

The Philippine Agriculturist and Forester

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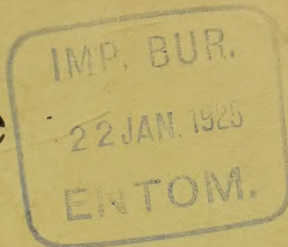
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The Student Body of the College of Agriculture
Los Baños, Philippines



A circular vignette showing a woman with short, wavy hair, wearing a light-colored, high-collared dress with a dark bow at the neck. She is seated and looking down at an open book resting on her lap. Her right hand is on the book's cover, which features a circular library stamp that reads "BIBLIOTHEQUE DE LA VILLE DE PARIS". The background consists of rows of bookshelves filled with books. The entire scene is enclosed within a circular border.

A circular vignette showing a woman with short, curly hair, wearing a high-collared dress, sitting and reading a large, ornate book. The book's cover features a circular emblem with the text 'THE UNIVERSITY OF CHICAGO' and '1892'. In the background, a bookshelf filled with many books is visible.

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A Report on a Collection of Living Dioscoreas from the Philippine Islands

By I. H. BURKILL,

Director of Botanic Gardens, Singapore.

In January, 1914, the following were so good as to send me nearly eighty tubers of *Dioscoreas* from the Philippine Islands,—the Bureau of Agriculture, through Mr. O. W. Barrett, rather more than forty tubers, and Professor C. F. Baker, of the University of the Philippines, nearly as many. Professor Baker generously wrote with the tubers that the excellence of the collection was largely due to his subordinate, Mr. Raymundo.*

The tubers on receipt were photographed in a group, and were afterwards planted in five well manured trenches prepared for them at the back of my house in the Botanic Gardens, Singapore. Notes were made on their above-ground parts from time to time; and on

October 19th, they were dug and underwent the final examination of the season upon which the following notes are largely based:

Dioscorea aculeata, Lam., *Dioscorea triphylla*, Linn., *Dioscorea pentaphylla*, Linn., *Dioscorea bulbifera*, Linn., *Dioscorea luzonensis*, Schauer, *Dioscorea myriantha*, Kunth, *Dioscorea alata*, Linn., and an undertermined species of the section *Lasiophyton*¹ were represented. Of these *D. myriantha* failed; of the others were raised—

- 10 *Dioscorea aculeata*, Lam.
- 4 *Dioscorea triphylla*, Linn.
- 2 *Dioscorea pentaphylla*, Linn.
- 1 *Dioscorea* allied to *D. Cumin-gii*, Prain and Burkill.
- 2 *Dioscorea bulbifera*, Linn.
- 9 *Dioscorea luzonensis*, Schauer.
- 40 *Dioscorea alata*, Linn.

* A paper on the cultural characteristics of Philippine yams has already been written by Mr. Raymundo, embodying the observations on one generation of a large series of varieties raised on nursery scale. The second generation is now approaching maturity in the field, and the paper is being held until this crop shall be harvested.—Editor.

¹ See Prain and Burkill, *A Synopsis of the Dioscoreas of the Old World*, Africa excluded, in the *Journal of the Asiatic Society of Bengal*, 1914, p. 7.

In the notes which follow the species are taken in the order of their names above.

DIOSCOREA ACULEATA, Lam.

The ten plants which were raised were found to belong to two varieties, and in the second variety to three races, thus:—

var. *spinosa*, as in figure 1.

var. *fasciculata*, race *a*, as in figure

2. " " race *b*, as in figure
3. " " race *c*, as in figure
- 4.

The variety *spinosa* is distinguished from the variety *fasciculata* by the presence of thorny roots. On each of the four plants of it grown, one thorny root only was present, instead of the many that are sometimes developed. The tubers were produced on long stalks, in one case 40 cm. long; and thus they were remote from the base of the parent stem. The greatest number of tubers on any one of the four plants was five, and the largest (figure 1) weighed about 2,440 grams. The greatest total weight on any one plant was 3,260 grams. Thus it is seen that the variety *spinosa* (in this race at least) stores the chief part of its nutriment in one tuber.

In the variety *fasciculata*, which may be considered originating in cultivation, it is usual for many and smaller tubers to be developed; and in accordance with this rule the largest of the tubers in race *a* attained only 680 grams, and the largest of the tubers in race *b* attained only 114 grams. The greatest weight produced by race *b*, of which three plants were grown, was 1,050 grams. Race *a*, of which there was but one plant, produced 2,070 grams of tubers. Race *b* produced tubers up to 16 in number. Of the two races *a* and *b*, the

former approaches the variety *spinosa* more closely than the latter in every respect, as the figures given show.

Race *c* with few-toed tubers is very like the burmese race "tah-dwe u" (i. e. "letter *d* yam" because its lobes suggest the burmese letter *d*). The shoots of this race died down early, and it is to be asked if the precocity is characteristic.

DIOSCOREA TRIPHYLLA, Linn.

All the four plants of *Dioscorea triphylla* raised proved to belong to the variety *reticulata*, Hook, f. (= *D. hirsuta*, Blume). All had bright yellow flesh.

DIOSCOREA PENTAPHYLLA, Linn.

As figure 5, is given the tuber of a male plant which flowered, and has been placed in the variety *malaica*. It came from the Department of Agriculture as No. 1022; it appeared above ground in the beginning of April, and flowered in October, being in each of these two respects one month earlier than a plant of the same variety grown alongside it from Penang.

Dioscorea sp. near *D. Cumingii*,
Prain and Burkill.

Half of the copiously branched tuber is represented as figure 6, which was produced by a plant whose foliage suggested *D. Cumingii*, but which did not flower. The parent tuber came as No. 1560 from Professor Baker. It produced a very vigorous shoot early in March, and died down in October. Like the preceding it produced many small bulbils.

DIOSCOREA BULBIFERA, Linn.

Dioscorea bulbifera, var. *sativa*, was grown certainly in one plant and probably in two. The first was received from the Department of Agriculture with the label "from Indo-China."

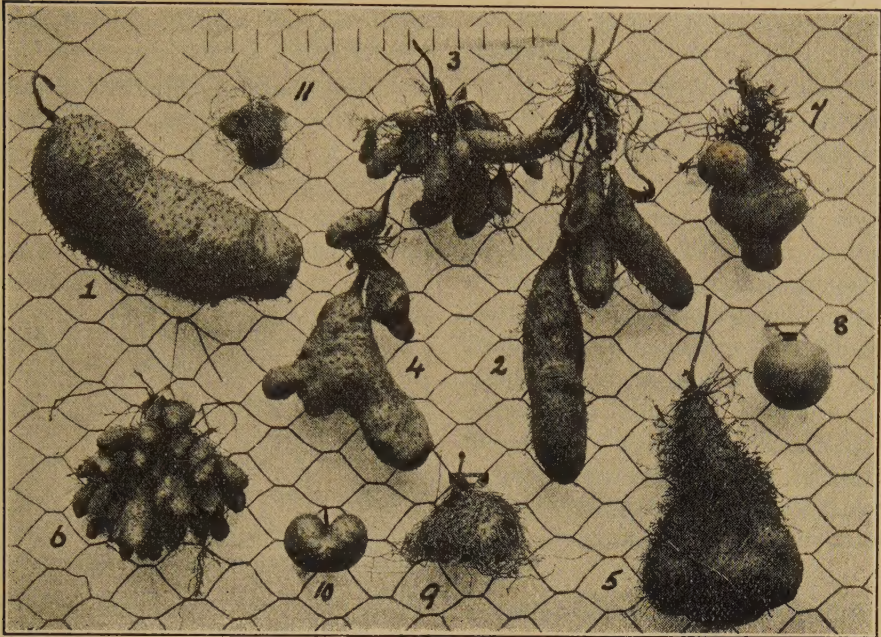


PLATE I.

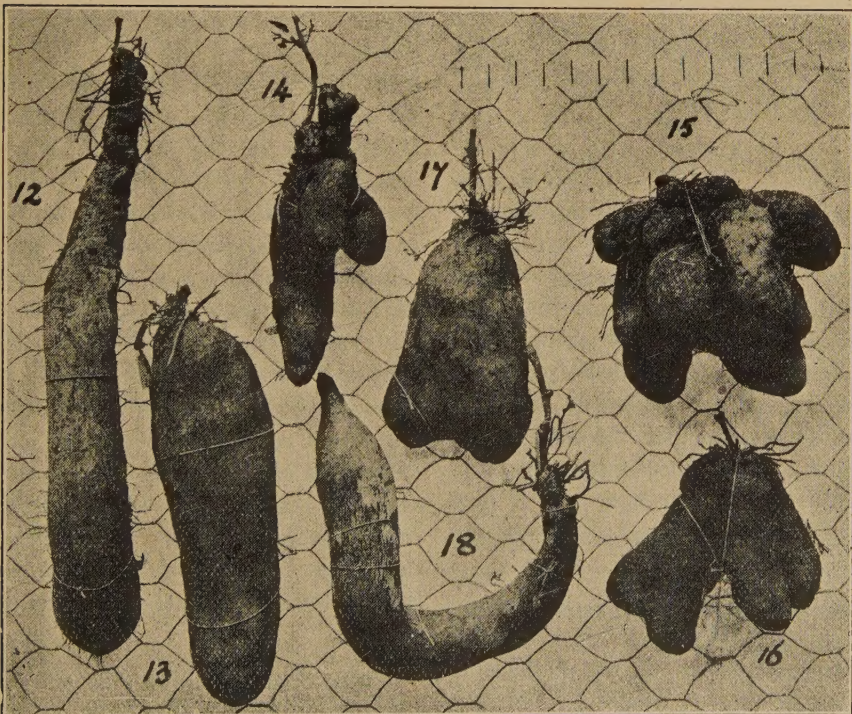


PLATE II.

A bulbil and its subterranean tuber are shown in figures 8 and 7. The largest bulbil weighed 200 grams.

On the same plate, as figures 9 and 10, are shown a bulbil and the subterranean tuber of an inferior race of *Dioscorea bulbifera* var. *sativa* which is common about the Tanglin district of Singapore and which was grown in cultivation alongside the first named. The reader will observe the abundant roots on the tuber and the corresponding root scars on the bulbil. As figure 11 on the same plate is given a small subterranean tuber of *Dioscorea bulbifera*, var. *vera* from Penang, which was cultivated in the same trenches.

DIOSCOREA LUZONENSIS, Schauer.

The plants of this species appeared above ground in March and began to show signs of the end of their vegetative season in October. Two flowered, one of each sex, and the fruit was nearly ripe in September when some accident destroyed it. The tuber of the largest plant was 77 cm. long and flattened and toed at the extremity.

DIOSCOREA ALATA, Linn.

Without doubt the parent form of *Dioscorea alata* buried its (usually) single and unbranched tuber deeply; and from such a condition man has evolved the forms that we know. But of the degree in which these forms are fixed we are quite ignorant and for that reason Sir David Prain and I have avoided the definition of a large number of varieties under the species.

The features of the collection will be given *seriatim*.

Robustness. Big yams are commonly coarse. Moderate size was on the whole a feature of the collection, there being more weighing between 1,000 and 1,500 grams than of other

weights. The largest of all weighed almost 5,000 grams.²

Some years ago Sir David Prain and I had, by the kindness of Mr. Jackson of the Queensland Sugar Refining Company, a large collection of yams from Fiji, and comparing them with this Philippine collection it may be remarked that on the whole they ran larger.

Branching occurred in rather more than half of the tubers. Unbranched tubers are figured in plate II as Nos. 12, 13, and 18; figure 15 of the same plate is of a considerably branched yam. Branching appears to be more a feature of the Philippine yams than of the Fijian, at least as far as these collections show.

There are two kinds of branching, one of which occurs from the woody knot at the neck and results in twin or triple tubers. It occurred in two plants only. The other is of the tuber itself, as in figure 15. Again there are two subdivisions of the latter kind of branching,—the usual one in which the branches are extruded on all sides, and the other, a kind of fasciation, which results in a flat tuber. Such flat tubers are seen in figures 16 and 17.

Succulent shoots, arising for the growth of the next season before the one is finished, are common in the yams of Burma, but occurred in only two of the yams from the Philippine Islands. One of these two is given as figure 14.

Rootiness. Coarse yams often have abundant roots on the surface. Figure 12 shows such a rooty yam, and figure 13, one free from roots. Relatively few of the Philippine yams proved to be rooty. Rootiness in *D. alata* is often associated particularly with elongation.

² An outline figure of these will appear in the *Gardens' Bulletin*, Straits Settlements, Vol. I, No. 8.

Colour. Two-thirds of the yams grown had purple sap in their tubers; and in one-third this purple sap was not confined to the surface but penetrated deep into the tissues. When present in the tubers the colour is also present invariably in the pulvini of the leaves, and often in the frills of the stem.

Tubers with purple sap may be elongated or not, and may be rooty or not; further, the presence of this colouring matter is not connected with size, although the majority of the largest were without it. Two tubers had a salmon flesh.

None on being cut produced rapidly that brown oxidation product which so many of the nauseous wild yams show.

Extruding tubers. Figure 18 is of an upcurving tuber the end of which emerged from the soil nearly a foot away from the parent stem. Four such extruding tubers were grown, two being as figure 18, and two others much branched and the branches flattened. That man should have selected such a condition is of much interest and it is of the greatest interest yet to ascertain how far fixed it is. When extrusion is unaccompanied by flattening of the tuber e. g. as in figure 18, it would appear as if man had selected out the responsiveness to gravity which appears to be generally characteristic of *D. alata*. When the extruding tubers are flattened, we may perhaps claim that the disturbance of something like fasciation interferes with it.

In the Shan hills there is a "Bull's-Horn yam" of like shape; and in Eastern Bengal, etc. we get the "oar yam" which curves and is fasciated, but does not curve so much as to extrude from the soil.

All the Philippine extruding yams had purple sap.

Intermediate between those just described and a more normal condition were two tubers one of which grew horizontally and the other grew obliquely in the soil.³ Both were with purple sap.

Prickles were present on three plants in the lower part of the stem. Two of these had short tubers and the other an elongated tuber. One had purple sap and two were without it. Plants with prickles were among those received from Fiji, and it had been thought that their development is in a measure connected with the Pacific Islands.

Leaf-shape. The leaves vary in shape, chiefly in the lobes which may be acute or rounded, may have straight or curved inner margins, and may stand wide apart or be drawn towards one another. The most marked leaf of all belonged to the plant which gave the tuber figured as No. 17; it was almost deltoid. Leaf-shape is not connected with any particular form or colour of the tuber.

Early maturity may be somewhat characteristic of the prickly-stemmed plants, and seemed to be more prevalent in plants with short tubers than in plants with elongated tubers. But the work of another year is advisable before making any positive statements.

In brief, except that purple sap was associated with extruding tubers, and rootiness with elongation, none of the characters runs of necessity with any other.

(The scale on the plates is in inches).

³ Of these also outline drawings will be published in the *Gardens' Bulletin*.

How To Prepare Mixed Fertilizers.

By HORACE G. DEMING

Professor of Chemistry

The practice of mixing fertilizers on the farm is being rapidly extended. Not only is the farmer thus assured of a raw material of fairly definite composition, but he is enabled to prepare a mixture more exactly suited to what his own experience has shown to be profitable than would be possible with most of the brands of commercial mixed fertilizers.

The saving in first cost is also at times considerable; nevertheless there are certain points in this connection that should be carefully noted. It would not be fair to compare the price of raw material bought in carload lots for cash with that of small lots of mixed fertilizer bought on long extensions of credit, and then call the difference profit due to the home-mixing of fertilizers. Neither should the farmer forget that his own time is worth something, and a reasonable estimate of its value should be included in a statement of the cost to him of the fertilizer that he has mixed himself. Again, the manufacturer of mixed fertilizers is generally provided with machinery that permits a more intimate mixing of the material than is generally possible with the primitive methods that the farmer is forced to employ.

In the preparation of home-mixed fertilizers the farmer should as a rule purchase high-grade material. If it can be demonstrated, for instance, that a crop is decidedly benefited by the addition of nitrogen, it will usually be found that a greater amount of that element can be purchased in the form of ammonium sulphate or dried blood, for a given amount of money, than would be possible if the nitrogen were

present in the form of garbage tankage, copra cake, or cotton-seed meal. Cheap raw material is therefore not necessarily economical unless the price is still reasonable when recalculated to a basis of *kilos of actual plant food*.

Throughout a large part of the United States, before the outbreak of the European war, the commercial value of the principal raw materials was about eighty-five centavos a kilo for nitrogen, twenty-five centavos a kilo for potash and phosphoric acid in available forms, and ten centavos a kilo for phosphoric acid in ground phosphate rock. These prices are for raw material bought in ton lots for cash at the principal distributing centers, some of them at a considerable distance inland. To these figures one should add a reasonable amount to cover the cost of freight to the local market, together with a certain percentage of profit for the local retailer, and interest charges if the fertilizer is bought on credit, in order to get a fair local market price.

Now when the relatively great cost of railroad transportation as compared with ocean freight is taken into consideration, it cannot be considered that the Philippine Islands are much farther from the centers of supply in Chile, Germany, and the Bahama Islands, than are inland states like Ohio; the local price of fertilizer should therefore be compared with the figures given above, and any great surcharge, after making the allowances that have been mentioned, should be made the subject of inquiry. It is reasonable to suppose that the present local prices may be somewhat reduced if the use of fertilizers in the Philippine Islands should be greatly increased.

In preparing mixed fertilizers one should remember that certain combinations of raw material are to be avoided. Thus limestone, quicklime, basic slag, or calcium cyanamide (nitrolime) should never be mixed with ammonium salts or superphosphate. In the former case a portion of the nitrogen would surely be lost as gaseous ammonia, while in the latter a part of the soluble phosphoric would become non-available. If superphosphate is mixed with kainite, without the addition of organic matter, there is great danger of the material setting to a hard mass that would be difficult to spread. Again, one should not mix nitrates with fresh manure or green cover crops in the preparation of composts, since there is danger of loss of nitrogen by reduction. This happens especially where nitrates and ammonium salts are present together in such a compost. One should not use nitrates, ammonium salts, or calcium cyanamide in a fertilizer to be applied to the soil during the rainy season, since there is danger of loss by leaching, especially in the case of nitrates.

On the other hand, the mixing of superphosphate or double superphosphate with such material as copra-cake or tankage is in general good practice, since the phosphate is thus made more fit for spreading on the soil, and the nitrogen of the organic matter may be made more available by the action of the acid. Ground phosphate rock appears to be somewhat more available when mixed with fermenting organic matter; it may even be fed to animals, mixed with their food, and thus intimately mixed with organic matter in the manure, its availability being somewhat increased by passage through the digestive tract.

The farmer should prepare such mixtures as his own experience or that of

a neighboring experiment station has shown to be profitable, since the chemical analysis of soils, or the study of the composition of the ash of the crop cannot in general furnish information as to what kind and quantity of fertilizer will pay. Again, one should remember that fertilizers rarely pay if used on soil that is not properly cultivated and kept free from weeds, or if the crop is subject to injury by insects or disease. In any case increasing amounts of fertilizer will fail to give proportionate increase of yield, and any amount of fertilizer may prove to be a source of loss if applied unintelligently or if the season happens to be very unfavorable.

Assuming that one has secured information as to the proportions of plant food that are most likely to be a source of profit, it is a simple matter to calculate the composition of a mixed fertilizer which, when applied at a definite rate per hectare, will furnish the elements needed in proper amounts. One needs then to select from the various high-grade fertilizers those that may be mixed with little danger of depreciation, choosing from the various stocks on the market those that experience has shown to be the most profitable or that appear to contain the most plant food for a given amount of money. When this has been done we still have to calculate the proportions in which the raw materials need to be mixed to give a fertilizer of the selected composition.

Now, while it is possible to solve problems of this sort by ordinary arithmetic, where but a single element of plant food is present in the mixed fertilizer in determined quantity, more complex cases have usually been treated by the method of trial and failure. It is easy to show by algebra that the number of different raw materials needed

to make a fertilizer of definite composition will in general be *one greater* than the number of elements to be considered; but even in cases where this number of ingredients is at hand, it will frequently be found impossible to compound the mixture needed, since the negative values that algebra often furnishes cannot be realized in weighing out the components of the mixture.

Let us first consider the case where two different fertilizers containing nitrogen are to be mixed. Given dried blood containing $12\frac{1}{2}\%$ nitrogen to be mixed with tankage containing 6.4% nitrogen to furnish fertilizer containing 8% nitrogen. Arrange the data in a rectangular form, putting the percentage composition of the desired mixture in the center, thus:

	% N.	Parts by Weight.
Dried blood.....	12.5	1.6
	8.0	
Tankage.....	6.4	4.5

Subtract, *along the diagonals of the parallelogram*, 8.0 from 12.5, putting the result, 4.5, at the other end of that diagonal on which the first two numbers occur; and subtract 6.4 from 8.0, putting the result, 1.6, at the other end of *its* diagonal. The data thus arranged indicate that to make the mixture there will be required 1.6 parts by weight of dried blood for 4.5 parts by weight of tankage, which in a 1000 kilo mix would be $16\frac{1}{61} \times 1000 = 262.3$ kilos of dried blood, and $1000 - 262.3 = 737.7$ kilos of tankage. This mnemonic scheme is taken from "Van Nostrand's Chemical Annual."

If definite weights of the fertilizer are to be made up it is more convenient to refer to diagrams about to be described, giving directly the number of pounds or kilos of each component of the mixture. The charts that appear here have been so much reduced in photographing that they are of no prac-

tical use as they stand; but directions will now be given for constructing them on a larger and more practical scale.

Secure a sheet of ordinary cross-section paper about ten by twelve inches or larger. Draw a base line OD (Fig.1) and lay down a horizontal scale, letting one main division represent 10 pounds, 25 pounds, 100 pounds, or some similar quantity; the unit should be so chosen that the quantity of fertilizer to be mixed should represent a distance of at least ten inches. At the right-hand end of the horizontal scale erect a perpendicular DA of any convenient length, and lay down a vertical scale of percentages, letting each main division of the cross-section paper equal $1\frac{1}{2}\%$, 1%, or some similar value, according to the maximum percentage of the constituent to be considered, and the size of the divisions of the cross-section paper. In the drawing from which Figure 1 was reduced each of the main (centimeter) divisions along the horizontal scale was made equal to 50 pounds, and each of the main (centimeter) divisions of the vertical scale to 1% of nitrogen.

Let us suppose that we are to prepare 1000 pounds of a fertilizer containing 5% of nitrogen by mixing dried blood containing 13.7% nitrogen and ground limestone or some other filler containing no nitrogen. Draw the lines OA and OC to connect the point O of the horizontal scale with the 13.5 and 5% graduations respectively on the vertical scale. From the point M' representing 1000 pounds of mixed fertilizer let us travel vertically to M, where we cross the 5% line; then move horizontally to the left until we cross the 13.7% line at Q; finally drop down to cross the base-line at Q' where we read 370 pounds of dried blood. The remainder, $1000 - 370 = 630$ pounds, is the weight of filler needed.

Similarly, if 1000 pounds of 5% fertilizer were to be made from tankage containing 8.3% nitrogen, draw first the line OB representing 8.3% nitrogen. From the 1000 pounds graduation at M' travel first to M, then horizontally until the 8.3% line is crossed at N, then vertically down to N' where we read 605 pounds tankage.

It is plain that if both dried blood and tankage were to be used in making up the fertilizer mixture, the weight of the former could not exceed 370 pounds, which is the weight that would be needed if no tankage were used at all; in other words the point R from which a perpendicular is dropped on the base line, to give the weight of dried blood to be used when tankage is also employed, must lie somewhere between O and Q. Therefore, to ascertain to proportions in which dried blood, tankage, and filler will need to be mixed to give a fertilizer containing 5% of nitrogen, travel upward from O along the 13.7% line to any point R between O and Q, the point at which the horizontal through M crosses the 13.7% line. Now draw a line RP parallel to the 8.3% line until the horizontal through M is crossed at P. That portion of the base-line that lies under the segment OR of the 13.7% line is the amount of the 13.7% fertilizer that the mixture must contain; that portion lying under the segment RP of the line drawn parallel to the 8.3% line is the amount of 8.3% fertilizer to be taken, while the rest of the mixture is filler. Thus we read 160 pounds of dried blood, 340 pounds of tankage, and 500 pounds of filler.

Of course this diagram may be used conversely to determine the composition of fertilizer mixtures in which several components have been mixed in determined amounts. Thus, suppose that a mixture is to be made up con-

taining 160 pounds of 13.7% material, 340 pounds of 8.3% material, and 500 pounds of filler. Beginning at O pass along the 13.7% line to the point R where it cuts the perpendicular through the point 160 on the horizontal scale; from this point draw a line parallel to the 8.3% line until it cuts the second perpendicular at P; from P move horizontally until the perpendicular through 1000 pounds (the weight of the mixture to be made) is crossed. Connect the point M thus located with O, and produce the line thus gotten until it cuts the vertical scale of percentages at 5.0, which is the percentage of nitrogen in the mixture.

It is of course unnecessary in practice to draw the vertical and horizontal lines in the diagram since the eye may follow along the cross-section lines. With a little practice problems of this kind may be solved almost instantly with the aid of the diagram. A great saving of time is thus effected where many mixtures of fertilizers have to be prepared; for a single mixture it is of course self-evident that the construction of the diagram would require more time than would be saved by its use.

Passing now to cases where two elements of plant food need to be considered in making up the fertilizer mixture, we have an entirely different type of chart. In Fig. 2, mixtures of fertilizers containing nitrogen and phosphorus have been considered. Along a horizontal scale lay off percentages of nitrogen, letting each main division of the cross-sectioning represent $\frac{1}{2}\%$ of nitrogen. At the right-hand end of the diagram erect a vertical scale letting each main division of the cross-sectioning represent 1% of phosphorus. The horizontal scale is to serve not only for percentages of nitrogen but for the weight of the mixture to be made,

expressed in hundreds of pounds. The finished diagram should be at least 10×12 inches.

Let it be supposed that we have to prepare a mixture containing 10% nitrogen and 4% phosphorus, there being available for the purpose the following raw materials:

	% N.	% P.
(a) Fish scrap.....	8.5	3.00
(b) Tankage.	10.4	6.65
(c) Dried blood.....	12.35	0.00
(d) Guano.	8.95	5.35
(f) Filler.....	0.00	0.00

First start from 0 and pass to the right to 8.5 on the nitrogen scale, then vertically to the horizontal line passing through 3% on the phosphorus scale. The point A thus located corresponds to the composition of the fertilizer a. In the same way locate the points B, C, and D, corresponding to the composition of the fertilizers b, c, and d, respectively. Since the filler contains no nitrogen or phosphorus, the point F representing it will coincide with the point O. Locate another point corresponding to the composition of the mixture to be made and call it M.

Now a glance at the figure will show that the point M lies within a triangle that may be constructed by connecting the points A, B, and C; this fact indicates that it is possible to make up the required mixture from these three raw materials. In the same way it will be seen possible to compound the mixture from fertilizers c, b, and f, since a triangle formed by connecting the points representing these fertilizers contains the point M. But it is impossible to make up the desired mixture from a, b, and d, in spite of the fact that some of these raw materials contain *more*, and others *less* nitrogen or phosphoric acid than the mixture. The first use of the diagram we have constructed is

therefore to make plain which of the different raw materials that may be obtained are suitable for making up a mixture of the composition desired.

Let us now suppose that a mixture of fertilizer weighing 1050 pounds is to be made up of the composition just given, and that considerations of economy direct that the combination of b, c, and f shall be used rather than any other of the combinations that the diagram shows to be possible. Connect the points B and C, and draw the line OM, which is produced to cut BC in S. That portion of BC which is most distant from B is to be marked b, and that which is most distant from C is to be marked c; in the same way, that portion of OS that is most distant from F we label f. Now connect the point S with that point on the baseline representing 1050 pounds, the weight of mixture to be made, and draw MY parallel to SZ to intersect the base-line at Y. Next lay off along OS the distances b and c previously given, using a pair of dividers, or making marks on the edge of a piece of paper. Mark the segments of OS thus found with the letters b and c. Connect the point B at the right-hand end of the last segment (c) with the point Y previously located on the base-line, and draw SX parallel with BY to intersect the base-line in X. The distance OX on the base-line, lying under the segment b, represents the amount of fertilizer b that must enter the mixture, namely 630 pounds; the distance XY, that lies under the segment c, represents the amount of c that must be taken, namely $950 - 630 = 320$ pounds; while the distance YZ, that lies under f, represents $1050 - 950 = 100$ pounds of filler.

If it is desired to make up 1050 pounds of the same mixture, but using this time the raw materials a, b, and c, the problem may be solved in a simi-

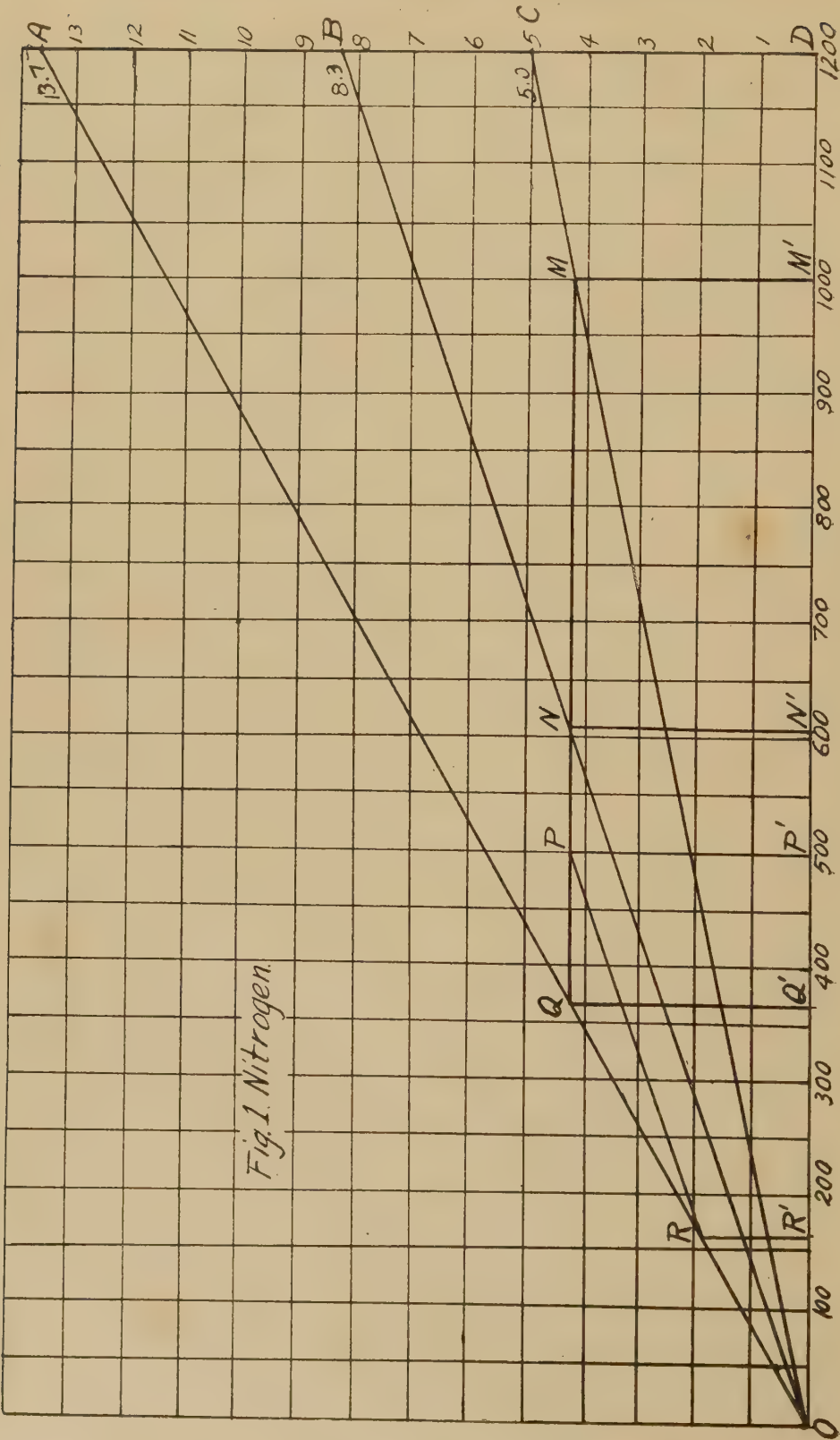
lar way. Connect B and C as before, and draw the line AM to intersect BC in T. The segment of AT that is the most distant from A is to be marked a, while the segments of BC on either side of the point T are to be marked b and c as before. Since the line AT if produced will not pass through the point O, it is necessary to draw an auxiliary line making any convenient angle with the base-line in the general direction OS; it is not necessary that this line pass through the point M. We lay off on this line, first the distances AM and MT, draw parallels, the outermost of which intersects the weight of mixture to be made, and then lay off the distances b and c on the same line, which, of course have different values from those that they possessed in the problem last discussed. The construction is finished and the weight of the constituents read as before.

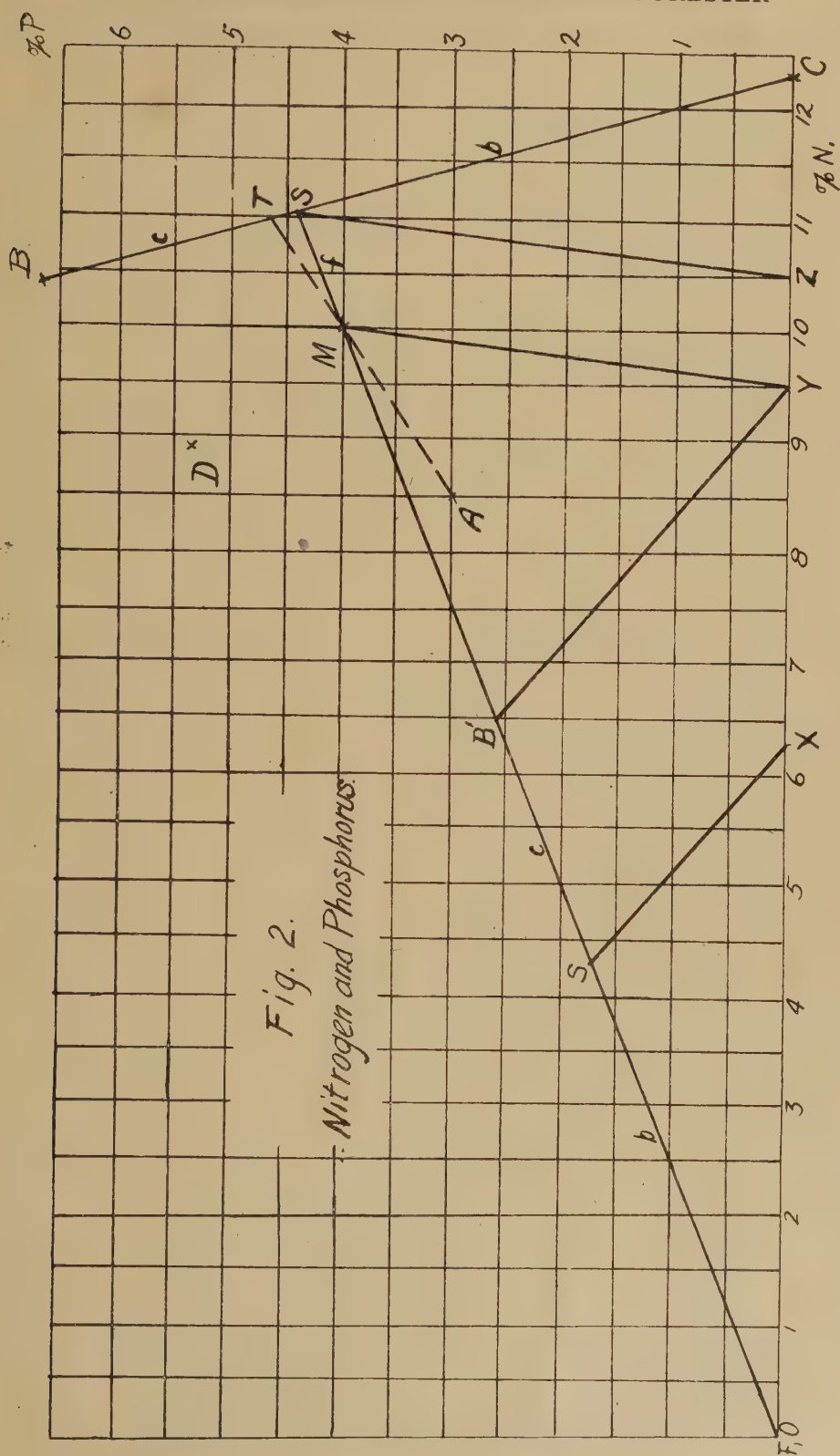
If it is desired to make a fertilizer in which potash is also to be considered, it is only necessary, after the percentages of nitrogen and phosphorus have been adjusted, to calculate the amount of potash salt to be added to give the desired percentage of potash, and then substitute this weight of potash salt for an equal weight of filler. Thus, in the problem above where filler is used, if the fertilizer were to contain 1% of potash in addition to the percentages of nitrogen and phosphorus named, and if kainite containing 15% of potash were available for that purpose, the weight of potash needed would be $1\% \times 1050 = 10.5$ pounds, which would require $100/15 \times 10.5 = 70$ pounds of kainite. Sub-

stituting this weight of kainite for filler (previously calculated to be 100 pounds) we would have left $100 - 70 = 30$ pounds of filler in the new mixture.

It is plain that if we had wished to introduce a much greater quantity of potash into the mixture than the 1% just called for, we should have had an insufficient amount of filler to be replaced by kainite; in this case we should have to use a potash salt containing a higher percentage of potash, or a mixture of nitrogen or phosphorus fertilizers containing a higher percentage of these two elements, in order that a greater weight of filler might be called for.

Another diagram, very similar to the last, has been devised that permits the compounding of four different raw materials to give a mixture containing determined percentages of three different elements. But, since fertilizers containing potash may in practice be determined by the method just described, this chart is of more practical use in connection with other lines of chemical work, such as the manufacture of cement. It will therefore be published elsewhere, in connection with a general study made by the writer of graphical methods of chemical computation. It is of interest to note in closing that the methods and charts just described can be used to advantage in the calculation of standard rations for animals, and are in fact the only quick methods for adjusting rations to a definite nutritive ratio, while maintaining at the same time definite weights of protein and digestible carbohydrates.





The Effect Of Fertilizers And Stimulants Upon The Growth And Production Of Corchorus Capsularis L.

Thesis presented for graduation from the College of Agriculture; No. 19.

By SOTERO FLORDELIZA ALBANO.

The great importance of jute fiber and of its by-products in the markets of the world, and the fact that this fiber is the product of countries having climates somewhat similar to that of the Philippines, have made it seem desirable to investigate the possibility of the economic production of jute in these Islands. Jute has been grown for a number of years at this College, but has always ripened at so small a size that it was not possible to make any use of the fiber. In these experiments, the author has tested the possibility of securing a better growth and yield by the use of fertilizers.

Knowledge of the relation of fertilizers, either organic or inorganic, to

the production of jute fiber, upon which a better or larger yield may be based, is very limited. F. Smith published in 1907 in the *Agricultural Journal of India* (Vol. 2, pp. 140-160) a paper in which he reports that in a three years' manurial test conducted at the Burdwan Experiment Station, Bengal, wherein nitrogen was applied at the rate of thirty pounds (30 lbs.) per acre (33.69 kilograms per hectare), cowdung as compared to castor cake, bonemeal, and bonemeal and saltpetre combined, gave the best result throughout, although in 1906 cowdung and castor cake stood very close together.

The following is a tabulation of the results at Burdwan, taken from his paper:

Plot No.	Kind of manure applied.	Per Acre, rate of Application. Mds. srs.		Outturn of		Fibre per Acre	
				1904 Lbs. per Acre.		1905 Lbs. per Acre.	1906 Lbs. per Acre.
1	Cowdung	68	20	1985		1805	1880
2	Castor cake	7	13	1635		1570	1860
3	Bone meal	11	10	1085		1580	1560
4	{ Bone meal	5	30	1605		1590	1600
5	{ Saltpetre	3	20	1230		1545	1560
	No manure						

1 = 1 maund = 40 seers = 82-2/7 lbs.

In the same paper Smith mentions a similar test which was conducted at the Cuttack Experiment Station during the jute season of 1906. As will be seen in the following table better results were always obtained when cowdung was applied in combination with

other ingredients than when alone, except in Plot 6, which, according to Smith, was planted to potatoes the previous year.

The following is Smith's statement as to yield per acre; and a recalculation into kilograms per hectare:

YIELD AT CUTTACK EXPERIMENT STATION

Plot No.	Manure Applied.	Amount Applied. Mds. srs.		YIELD OF FIBRE	
				Lbs. per Acre.	Kgs. per Hectare.
1	No manure	0	0	750.86	843.35
2	Cowdung	100	0	812.57	912.66
3	Cowdung	100	0	978.57	1099.18
	Saltpetre	1	20		
4	Cowdung	100	0	915.43	1028.19
	Superphosphate	3	0		
5	Cowdung	100	0	1090.29	1224.59
	Saltpetre	1	20		
	Superphosphate	3	0		
6	Cowdung (after potatoes)	100	0	20.95.20	2353.29

A study of the preceding tables shows that at Burdwan the ingredients ranked as follows:—Cowdung, castor cake, bone meal and saltpetre combined, and bone meal. At the Cuttack Station the order was, (not considering Plot 6) cowdung, saltpetre and superphosphate combined; cowdung and saltpetre combined; cow-

dung and superphosphate combined; and cowdung alone.

Since the publication of Smith's paper, nothing has been heard of other manurial tests with *Corchorus*. It is surprising that a plant of such economic value has not received more study.

LAND USED AND ITS PREPARATION

A uniform and level piece of land which was previously occupied by weeds was plowed, harrowed, and disked several times in succession. As far as records or the statements of old inhabitants show, this land was never manured before this experiment. A rectangular plot was laid out and divided into six smaller plots, 5 by 10 meters each, separated from one another by a path one meter wide. These plots were then treated as follows:

Plot No. Fertilizer applied.

- I No Manure.
- II Cowdung . . . 400 Kg.
- III Kainit . . . 10 Kg.
- IV No Manure . . .
- V Tankage . . . 12Kg. - K_2SO_4 —4K
- VI Tankage . . . 12Kg.

Tankage contains about 7 to 12% nitrogen and 10 to 5% phosphoric acid, the higher percentages of nitrogen being usually found with lower percentages of phosphoric acid; sulphate of potash contains about 54% of potash; kainit contains about 12½% of potash.

The fertilizers were applied broadcast on November 30, 1912. In order to be sure of an even distribution, the commercial fertilizers were first diluted with finely pulverized soil. Seeds were sown on December 2 and 3, 1912. Two kinds of spacing were used. Half of each plot was planted 20×20 centimeters apart and the other half 20×40 centimeters. The former spacing was

called A and the latter B. Three days after sowing the seeds, they began to appear and the average length of the germination period was four days. Thinning was done December 18 and 19, 1912, leaving only one plant in each "hill."

For indices of the effect of the fertilizers on the plants, the rate of growth, "the best index to the condition of any plant or crop", and the yield of fiber were both used. Accordingly, on December 22, ten plants which were as uniform in height as possible and at the same time well distributed in each division, were selected for growth measurement. Daily growth record was kept till January 19, 1913, when weekly measurements * were made till the end of the experiment (February 26). The experiment lasted only seventy-six days for the plants were then already maturing, and in most of them there was no longer any noticeable growth.

* Mr. Albano's tables would by themselves occupy about half of a number of the *Agriculturist and Forester*, and in detail are of interests to plant physiologists rather than of practical importance in agronomy. Accordingly, there are here published one sample table to give an idea of the rate of growth and of the uniformity of the plants, and a table which is a direct compilation of the results of the detailed measurements. In some plots there was less uniformity than in the one furnishing the table presented, but the uniformity in each plot was conspicuous. —Editor.

TABLE I.—GROWTH. PLOT V, DIVISION A.

	I	II	III	IV	V	VI	VII	VIII	IX	X
DECEMBER										
23	6	10	12	12	11	10	38	4	36	14
24	9	13	15	11	11	16	7	5	8	9
25	8	10	22	16	14	20	13	9	13	19
26	17	17	21	17	22	21	14	8	13	17
27	15	20	17	27	19	22	21	14	16	26
28	17	22	25	19	24	25	19	9	18	23
29	38	37	40	24	48	48	40	29	36	41
30	20	34	30	45	37	21	18	11	19	23
JANUARY										
2	68	67	68	81	70	93	67	52	65	87
3	28	25	31	27	23	18	27	20	23	28
4	33	38	34	34	32	45	27	21	30	36
5	31	35	35	42	31	39	23	24	32	43
6	40	41	55	48	41	40	43	34	34	48
7	35	36	37	40	35	37	34	17	39	41
8	38	43	35	48	41	46	39	49	19	50
9	35	45	47	30	42	34	34	28	28	45
10	49	53	48	50	50	56	53	40	64	54
11	42	46	35	46	42	45	41	42	46	46
13	85	83	41	47	90	85	79	58	72	84
14	21	40	49	62	32	33	40	57	42	34
15	40	28	24	35	34	48	34	34	13	37
16	40	43	21	35	34	41	31	52	33	34
18	68	45	46	53	46	43	70	59	49	46
19	30	22	24	15	23	23	25	28	25	17
26	167	191	131	103	129	125	200	169	173	153
FEBRUARY										
2	116	81	32	78	49	65	60	123	133	47
9	34	7	3	34	94	9	22	38	25	12
16	5	0	4	8	7	8	3	2	5	0
HEIGHT AT BEGIN- NING	65	97	118	99	89	109	65	86	61	90
HEIGHT AT END.	1210	1234	1100	1189	1220	1235	1185	1122	1250	1212

TABLE II.

Average Height Reached by the plants in Each Plot.

Plot No.	Division A.	Division B.
I	729.3	888.2
II	989.3	989.5
III	1061.7	1051.7
IV	880.6	1038.8
V	1195.7	1163.5
VI	1163.3	1141.8

As this experiment was conducted near the end of the year, when rain was already scarce and the soil was consequently too dry, a measure of failure might have been expected. However, the growth which is shown for the control plot in the preceding table is better than has been shown by most of the jute cultures at this college. Semler states that the successful cultivation of jute demands a hot and moist climate with a fair amount of rain. He further states that the ideal temperature for the luxuriant growth of jute is from 20° to 25° C. The rainfall during the course of this experiment is shown by the following table:

TABLE III.—RAINFALL IN MM.

Date.	Dec.	Jan.	Feb.
1	Trace	27.0	2.0
2	.....	206.0	Trace
3	.....	.....	Trace
4	.....	Trace	.....
5	Trace	1.0	.....
6	.....	1.0	.....
7	.....	4.6	.....
8	Trace	.....	.....
9	.....	.....	.....
10	28	2.0	.....
11	Trace	.....	.....
12	12	.....	2.7
13	7	.....	Trace
14	1	.....	.....
15	0.8	.....	.....
16	.....	.....	.....
17	4	.....	.....
18	2	.....	4
19	.....	.....	Trace
20	.....	.....	.....
21	.....	.....	16.0
22	.....	.....	.....
23	.....	.....	.....
24	.....	38.0	.....
25	13	6.0	.....
26	81	11.0	.....
27	1	1.7	.....
28	0.5	.....	19
29	.....	1.0	.....
30	14.0	2.0	.....
31	9.0	6	.....

TEMPERATURE—C.

	December	January	February
Maximum....	26.9	26.9	28.07
Minimum....	22.2	22.19	22.81

It is probable that Semler's ideal temperature is materially lower than would produce the most luxuriant growth of jute, provided the rainfall were thoroughly ample. Limited observations at this college, and general observations on tropical and sub-tropical crops here and elsewhere, make it seem probable that an average temperature above 25C would result in greater luxuriance than would any temperature below that point. Still, the absence of water and not of heat, has interfered with the growth of these cultures. Comparing table I with the rain record, the effect of showers is very conspicuous.

As the plants whose average heights are shown in Table II represented a fair average of the plants in each plot, it is safe to conclude that the best results were obtained in this experiment by the application of K-P-N. The fertilizers ranked as follows, taking the average for both divisions:—K-P-N, P-N, K-N, and N. (The result obtained at the Cuttack Experiment Station, Bengal, was K-P-N, K-N, P-N, and N.)

For data on the yield of fibre, the product from a square meter was taken as unit. At the distances used there should be in Division A twenty-five plants to the square meter, and twelve and one-half in Division B. In order to overcome the difficulty of using 12½ plants, fifteen were used and from the product of these, the corresponding yield of 12½ plants was calculated. The fibre was extracted by retting; this process took twenty-three days, except in Plot 5, Division B, which was extracted nine days earlier than the rest. This was intentionally done to see the effect of time on the color of the fibre. The result was that the one retted for fourteen days only lacked the glossiness of the fibre extracted from those

that remained in water for twenty-three days.

The following is a tabulation of the yield of fibre:

TABLE IV.—YIELD OF FIBRE

Plot No.	Division A.		Division B.		
	Yield per sq. m.	Per Ha.	Yield of 15 ps.	Per sq. m.	Per Ha.
1	11.9090 gms	119.090 Kg.	5.1572 g.	4.2976 gm	42.976 Kg.
2	11.230 "	110.230 "	12.4600 "	10.5500 "	105.500 "
3	18.4370 "	184.370 "	12.7798 "	10.6498 "	106.498 "
4	15.3000 "	153.000 "	13.8250 "	11.5208 "	115.208 "
5	22.9702 "	229.702 "	29.7300 "	24.7750 "	247.750 "
6	20.5900 "	205.900 "	15.0884 "	12.5703 "	125.703 "

An examination of the preceding table shows that, with the exception of Plot 5, the yield in Division A is larger than that of Division B, and if we take the average for each division, Division A is likewise better than Division B.

It is also to be noted that, in the yield, the same rank of the ingredients as in their effect on growth was again obtained. The order is as follows: K-P-N, P-N, K-N, and N.

For a financial analysis of the experiment, the fibre was assumed to be equal in value to the Chinese jute of Tientsin. The "Journal d'Agriculture Tropicale" published on January 31, 1913, gives the market price of Tientsin for January 20, 1913 as 52.25 francs which are equivalent to ₱20.69 per 100 kilos. It is from this figure that the valuation of the yield of fibre was based. On this basis the value of the crop would stand as follows:

TABLE V.

Plot No.	Manure Applied.	Actual Yield per sq. meter in gr.	Outturn of Fibre per Ha. in Kilos	COST OF CULTIVATION.			Money Value of Outturn.
				Cost of Manure Applied.	Cost of Labor.	Total.	
Division A.	1 No manure.....	11.9090	119.090	....	₱ 10	₱ 10.00	₱ 24.62
	2 Cowdung.....	11.0230	110.230	12.00	" 10	" 22.00	" 22.76
	3 Kainit.....	18.4370	184.370	52.68	" 10	" 62.68	" 38.07
	4 No manure.....	15.3000	153.000	....	" 10	" 10.00	" 31.66
	5 Tankage+ K ₂ SO ₄	22.9702	229.702	141.99	" 10	" 151.00	" 47.59
	6 Tankage.....	20.5900	205.900	84.00	" 10	" 95.00	" 42.62
Division B.	1 No manure.....	4.2976	42.976	....	₱ 10	₱ 10.00	₱ 8.90
	2 Cowdung.....	10.5500	105.500	12.00	" 10	" 22.00	" 21.72
	3 Kainit.....	10.6498	106.498	52.68	" 10	" 62.68	" 21.93
	4 No manure.....	11.5208	115.208	....	" 10	" 10.00	" 23.79
	5 Tankage+ K ₂ SO ₄	24.7750	247.750	141.99	" 10	" 151.99	" 51.31
	6 Tankage.....	12.5703	125.703	84.00	" 10	" 91.00	" 26.06

In the absence of any means of estimating the local cost of extracting the fiber, no attempt is made to estimate the loss or possible profit on the different plots.

As it has been noticed by the writer during the first set that the amount of

water given the plant exercises a great influence on the growth of *Corchorus capsularis*, a second set was started on January 21, 1913, with the object of testing whether irrigation may take the place of rainfall or not.

Plots which were exactly of the same

size as those used in the preceding experiment were laid, plowed, disked, and harrowed on the date mentioned above. The land used this time was not level but had a gentle slope. The fertilizers were applied on January 22 and 23,

1913 and worked in the following day. During the first experiment only four substances were tested; this time another combination was added and that is K-P. The plots were then treated as follows:—

Plot I	Cow Manure	400.00	K
II	Kainit	10.00	K
III	Tankage	12.00	K
IV	Tankage	12.00	K
V	Sulphate of Potash	4.00	K
VI	Control		
	Sulphate of Potash	4.00	K
	Bassio Slag	4.00	K

Planting was done January 25 and 27. The plots were again divided as in the first set. In division A the plants were set at 10×10 cm. and in B 20×20 cm. Germination took on the average three days.

The rate of growth was chosen as the index of the behavior of the plants. Daily and then weekly measurements were again made, but the tables are here omitted.

The growth from the beginning up

to March 7, 1913 was very slow. This is probably due to the fact that up to that date the water supply could not be controlled. After this date the growth was more rapid, the rate in the majority of cases being much greater than in the former set. The greatest height reached by any plant this time was 1560 mm. while that in the first set was 1474 mm., a fact which shows the good effect of ground water in spite of the climate's being drier.

TABLE VI.
AVERAGE HEIGHT OF THE PLANTS IN EACH DIVISION.

Plot No.	Division A.	Division B.
I	906.3 mm.	1266.1 mm.
II	976.6 "	1234.8 "
III	1096.3 "	1128.1 "
IV	1073.5 "	1018.2 "
V	1085.1 "	1058.2 "
VI	944.8 "	1125.7 "

From the preceding table it may be seen that, with the exception of Plots IV and V, Division B was far better than Division A.

The average for each division is as follows:—

Division A	1013.76 mm.
Division B	1130.68 mm.

As to the effect of the fertilizers used on the growth of the plants, the following table will show the rank in which they stand, taking the average for both divisions:

Plot No.	Ingredient	Average Height	Rank
I	N	1086.2 mm.	3
II	K-N	1105.7 "	2
III	P-N	1112.2 "	1
IV	K-P-N	1045.8 "	4
V		1068.2 "	
VI	K-P	1035.25 "	5

It will be seen from the preceding tables that the rank obtained was P-N, K-N, N, K-P-N, and K-P, while that of the first set was K-P-N, P-N, K-N, and N. This may seem surprising; but we should bear in mind that the location of the

land has a pronounced influence on the crop. This has also been the case in India, where at the Cuttack Station at Bengal, the rank was K-P-N, K-N, P-N, and N, while at the Burdwan Station, it was N, K-N, P-N, and K-P-N.

CONCLUSIONS AS TO FERTILIZERS

From the two sets of experiments just mentioned, we may draw the following conclusions:

1. The application of any kind of manure to *Corchorus* produces a pronounced beneficial effect on the growth of the plant and on the yield of fibre as well.

2. The best result was obtained by the application of a mixture containing nitrogen.

3. Cowdung alone at the rate of 8000 K. per hectare produced as good an effect as Kainit at the rate of 2000 K. per hectare (taking the average for both sets).

4. The best result was obtained when the plants were set at 20×20 cm. apart; 20×40 cm. and 10×10 cm. did not give as good a result.

At the same time that the second series of fertilizer experiments were

TABLE VII.

Plot No.	Amount Applied.	Strength of Application.	Average Height.
1	35.1136 g.	Na ₂ Bo ₄ O ₇	M/1000. 618.4 mm.
2	7.0227 g.	"	M/5000. 653.0 "
3	3.5114 g.	"	M/10000. 774.4 "
4	46.9350 g.	MnSO ₄	M/1000. 559.2 "
5	9.3870 g.	"	M/5000. 758.0 "
6	4.6935 g.	"	M/10000. 748.0 "
7	0.9387 g.	"	M/50000. 561.4 "
8	0.9387 g.	HgCl ₂	M/50000. 696.4 "
9	0.4693 g.	"	M/100000. 998.8 "
10	47.0915 g.	FeSO ₄	M/1000. 974.6 "
11	9.4183 g.	"	M/5000. 956.4 "
12	4.7091 g.	"	M/10000. 952.4 "
13	0.9418 g.	"	M/50000. 943.4 "
14	42.5231 g.	CuSO ₄	M/1000. 845.6 "
15	8.5046 g.	"	M/5000. 825.2 "
16	4.2523 g.	"	M/10000. 965.6 "
17	0.8504 g.	"	M/50000. 861.2 "
18	60.1081 g.	NiSO ₄	M/1000. "
19	12.0216 g.	"	M/5000. 934.4 "
20	Control	Control	756.8 "
21	"	"	740.4 "
22	"	"	880.0 "
23	"	"	815.6 "
24	48.6498 g.	ZnSO ₄	M/1000. 572.2 "
25	9.7255 g.	"	M/5000. 783.2 "
26	4.8649 g.	"	M/10000. 715.2 "
27	10.0000 g.	NaF	10 grams. 944.4 "
28	5.0000 g.	"	5 " 875.4 "
29	2.5000 g.	"	2.5 " 767.0 "
30	0.5000 g.	"	0.5 " 1126.8 "
31	10.0000 g.	KI	10.0 " 917.8 "
32	5.0000 g.	"	5.0 " 981.6 "
33	2.5000 g.	"	2.5 " 711.8 "
34	0.5000 g.	"	0.5 " 912.0 "
35	Control	Control	953.0 "
36	"	"	810.6 "

started, an attempt was made on a small scale to see if results of interest could be obtained by the use of stimulants. There have been many experiments on the use of stimulants with different crops, and the literature on these has been summed up by Mr. Roxas in Volume I, No. 5, page 89, of the PHILIPPINE AGRICULTURIST AND FORESTER. For the experiments with jute, plots of 1 meter square each was used, and tests were made of the effect of various applications of borax, manganese, mercury, iron, calcium, nickel, zinc, fluorine and iodine. The growth records daily and then weekly were kept on five plants of each plot. Since many of these plants died during the experiment, and because the records would require too much room, they are omitted here. The preceding table shows the amount of chemical applied to each plot; the strength of the application on the assumptions that a square meter of soil, 30 cm. deep, weighs 312.9 kilograms and that the chemical used was distributed through the soil to this depth; and the average height, attained by the measured plants in each plot.

Besides the conclusions which may be drawn from the figures presented in Table VII, it was very evident from the more detailed data showing the daily rate of growth that the initial growth of most of the stimulated plants was interfered with by the applications they received. A very large part of these plants showed initial blistering or other pathological symptoms. In the case of the stronger application of nickel sulphate, the plants died very early. The other cultures recovered more or less completely, and, in some cases, the growth during the latter part of the period was decidedly more rapid than would appear from the height finally reached. This initial interference and subsequent recovery may be due

to imperfect mixture of the stimulants with the soil, or to gradual accommodation on the part of the plant. It is accordingly to be borne in mind that it remains possible that better results would be obtained in other experiments from the use of some of these stimulants. With this qualification, the following conclusions can be drawn:

Borax, manganese sulphate, and zinc sulphate were injurious in all concentrations tested. In general, the injury was greater the stronger the application. Mercuric chloride was injurious when 0.9 gram was applied to the square meter, but beneficial when half this quantity was used. Copper sulphate interfered somewhat with growth when 42 grams or 8 grams were applied to the square meter, but seemed to be slightly beneficial when 4 grams or 0.8 gram was applied. The application of 60 grams of nickel sulphate was fatal, while the use of 12 grams was beneficial; the tallest individual plant measured was in the plot which received 12 grams. The recovery from initial blistering was especially conspicuous in this plot. Iron sulphate was beneficial in all quantities tested, ranging from 0.3 gm. to 47 grams. The absence of considerable difference in the effects of different quantities of iron is probably due to chemical changes which removed a large part of the iron from solution and the possibility of effectiveness. If this be true, it can be concluded that the application of very small quantities of iron is profitable, and that the use of larger quantities is merely wasteful. Three of the four plots treated with sodium fluoride showed an acceleration of growth, but one plot receiving an intermediate application had the growth retarded. The most vigorous plot in the whole series was the one treated with 0.5 gm. of sodium fluoride. Potassium

iodide applied 10 grams, 5 grams, and 0.5 gm. to the square meter accelerated the growth, but 2.5 grams would seem to have retarded it.

The failure of the control plots in this set of cultures to grow as well as did the controls in the accompanying series of fertilizer experiments is due to the fact that the stimulation experiments were carried on on the upper side of the irrigating ditch from which all of the jute grown at this time was provided with water.

The general conclusion to be drawn from these stimulation experiments is that jute is decidedly less subject to stimulation with various chemicals than are some of the other crops with which

experiments have been carried on, most notably, for instance, potatoes and radishes. The only chemicals whose use can be recommended as very likely to be profitable, as a result of these tests, are iron and very dilute nickel. It remains possible that applications of borax, manganese and zinc, more dilute than any which were tested in this experiment, would also result in an acceleration of growth sufficient to make their use financially profitable.

I am under due obligation to Professor E. B. Copeland for the plan of the experiment and for his valuable criticisms; to Associate Professor H. G. Deming and Mr. M. Roxas for the analysis of the fertilizers.

GOGO

"Entada scandens" is a climbing plant of the bean family said to be practically pantropic in its distribution. In the Philippines, both the plant and its commercial product are known as "Gogo". It grows in brush lands and in woods in various parts of the islands, and sometimes grows to huge size, reaching the top of trees, and the body of the vine attaining a diameter of 20 centimeters. As it is of considerable local commercial importance, the college has tried to secure it for a number of years, but without success. This year an especial effort was made with the result that a number of students brought seed. These were Segundo Panganiban, who secured his seed in Amadeo, Cavite; Leon Villanueva and Camilo Guevara, also from Amadeo; Pedro Rojas from Indang; Pio Porcioncula from Tanay, Rizal; Vito Rada from Alaminos, Pangasinan; and Gregorio Quezon from Nueva Ecija. The principal source of Gogo is the hills of Cavite, from which four of our lots of seed were obtained.

In this district, red and white varieties are distinguished, and both of these grow both wild and cultivated. Cultivation consists in hardly more than planting them near big trees. For propagation, the seed is always used in this locality, and the stem is said to decay if put in the ground. Germination requires a month or so, and the plants are ready to use when two years old. They live indefinitely. Vines of any age are cut, but when very old ones are used, they are more often sliced into than cut across. Using vines of moderate size, they are cut into lengths of .30 cm. or somewhat more, and are then split into pieces about the diameter of the thumb. These pieces are then pounded flat on stones and are then dried. Such dried ribbons have rather the aspect of bark, and the product is commonly spoken of as "Gogo bark," although it is really a part of the wood of the vine. These pieces sell locally for two and a half to four pesos a thousand. The sale may be in the hill

(Continued on page 242)

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UNIVERSITY NEWS

Summer Courses in the College of Agriculture

The Dean has issued the following announcement:

The annual school session of the College of Agriculture will open April 5th, and will close a week before the opening of the regular college year. Two courses will be given this year which are open to students not already matriculated in the college. These are Botany I, and Trigonometry and Surveying, which constitute the last half of Mathematics III. Both of these are offered in order that students entering college as graduates of high schools, or with advanced credit for work done in high schools, may make up subjects in which they are sure to be behind the regular work of the classes they will enter. In Botany I, a maximum of 90 students can be received. As this is a larger number than it was ever possible to receive in the past, it is probable that all who desire to take this course can be accepted. It is strongly recommended that all students intending to enter college this year with advanced credit present themselves promptly at the beginning of the summer for this course.

Work in both subjects will be morning and afternoon, daily, and in this way it is possible to finish the courses during the vacation period.

For students already in the college, German II is offered to a class of not

more than 40. A course will also be given, as last summer, in Chemical Arithmetic for the benefit of those whose imperfect previous training in Arithmetic makes Chemistry exceptionally difficult. There will also be the usual work of thesis students.

COLLEGE OF AGRICULTURE ALUMNI ASSOCIATION

The next meeting of this organization will take place in Manila on the Commencement Day of the University, March 30, 1915. Among the several important matters that will be taken up in the meeting are the election of permanent officers, creation of standing committees and the initiation of the graduates of 1915. A banquet has been proposed to which some important visitors will be invited.

DEPARTURE OF PRESIDENT BARTLETT.

It is with heartfelt regret that we announce in this issue the separation of Dr. Bartlett from the University of the Philippines, after having been its President for about three years. President Bartlett's resignation takes effect on April 1st.

The whole University, through a General Committee composed of representatives from the different Faculties, Alumni and Student Bodies is planning for an impressive celebration to be held on March 27 in acknowledgment of the event.

A Study of Indian Corn (*Zea Mays*)

By JOHN C. RUNDLES,

Instructor In Agronomy

Corn is one of the six staple crops of the Philippines, ranking third in the area devoted to its cultivation and fifth in the total value of its products. It is successfully grown in several parts of the Islands. A great effort is being made to extend the acreage and to increase the use of the crop. Success has resulted in regions where conditions are favorable for its growth, but in the unfavorable regions corn cannot be grown profitably. Under the latter conditions further attempts cannot but result in almost absolute failure. The real importance of the crop is not generally recognized in these Islands. There is no doubt that, when better methods for storing are used and when the appreciation of its worth as food for man and beast is more fully realized, the crop will have an increased value.

Corn has been studied at the College of Agriculture, with the view of becoming better acquainted with the conditions governing its growth, and better methods for improving the varieties through breeding, hybridization, selection and acclimatization. An effort has been made to standardize the varieties for the different regions of the Islands, but this has not met with success. How-

Credit is due to H. O. Jacobson, Bureau of Agriculture, for his criticism of the directions for the use of the score card; to C. F. Baker, for his helpful suggestions; and to F. C. Gates for his review of the outlines.

THE ADVISABILITY OF CORN STANDARDS

The corn growers of Indiana, Illinois and Iowa and, in fact, the growers of every corn region, have long recognized the necessity of variety standards for corn. They have found that varieties behave differently when grown in the different regions. For example, Illinois has different standards for the same varieties grown in Northern, Central, or Southern Illinois.

The Moro variety of corn grown in Mindanao is larger in every respect than the same variety grown in Luzon. The average weight of the best 50 ears produced in Mindanao was found to be 30% greater than that of selected ears of the same variety grown in the Visayas.

It is a self-evident fact that varieties differ wonderfully. Standards worked out at the College of Agriculture, Los Baños, for a few varieties will plainly indicate this fact.

Variety.	Circumference in cm.	Length in cm.	Weight in grams.	% grain.
Yellow Flint.....	12.5 to 14.0	18 to 21.0	175 to 185	83
Pasig Flint.....	11.5 to 14.0	14.0 to 16.0	125 to 135	80
Mexican June.....	14.0 to 16.5	15.0 to 18.0	170 to 180	84

ever, standards for use in the corn judging classes of the College of Agriculture have been established for the varieties grown in that vicinity. The score card employed is the one officially adopted by the Bureaus of Education and Agriculture and the College of Agriculture.

There is also a great variation of characters within a variety. The native yellow flint varies as follows:

Texture of endosperm—from 20 to 90% corneous.

% of grain—from 70 to 88%.

Weight of ear—from 50 to 240 grams.

Shape of ear—very tapering to cylindrical.

Shape of kernel—narrow and deep to wide and shallow.

Not only is variation found in every character of a variety, but an even greater variation is found among different varieties. The purpose of a variety standard is to establish and to define the characters which are to govern seed selection and corn judging. The standard defines the type; it makes

clear the variety differences; it is a guide to the corn judge; it enables the grower to select his seed along the most scientific lines; it recognizes the vast possibilities of a variety; it designates the desirable shape and texture of the kernel, the shape and weight of the ear, and the per cent of grain. Progress is certain because the seed selection follows along a definite line of improvement, year after year. The standards are gradually adjusted as improvement advances.

SCORE CARD FOR CORN
COLLEGE STANDARDS FOR VARIETIES

	<i>Yellow Flint.</i>	<i>Pasig Flint.</i>	<i>Mexican June.</i>
% of grain.....	83	80	84
Length of ear in cm.....	18 to 21	14 to 16	15 to 18
Circumference of ear in cm.....	12.5 to 14	11.5 to 14	14 to 16.5
Weight of ear in grams.....	175 to 185	125 to 135	170 to 180
Color.....	Yellow	White	White
Texture.....	Corneous	Corneous	Starchy
Shape.....	Tapering	Tapering	Cylindrical

No.	Scores.	Value.	Credits.
1. Uniformity of exhibit.....	10		
2. Market condition.....	5		
3. Purity of grain color.....	5		
4. Shape of ear.....	10		
5. Proportion of ear.....	10		
6. Butt of ears.....	5		
7. Tip of ears.....	5		
8. Space between rows.....	10		
9. Per cent grain to ear.....	15		
10. Trueness to type.....	10		
11. Shape of grain.....	5		
12. Uniformity of grain.....	5		
13. Weight of ear.....	5		
Possible credits.....	100		
Credits given.....			

Name of Variety.....
Name of Student.....

DIRECTIONS FOR THE USE OF THE SCORE CARD FOR CORN, AND AN EXPLANATION OF ITS POINTS

The usual number of ears which constitute an exhibit is 5 or 10. It is best

to include an extra ear with the exhibit to be used in determining the per cent of grain. This ear can be shelled, the per cent of grain obtained, and used to represent the sample, thus leaving the exhibit intact. The following directions presume an exhibit of 11 ears.

I. Uniformity of exhibit—10 points.

The ears making up the exhibit should be alike. Uniformity indicates pureness of variety. It includes similarity in length, shape, and color of ears, in tips, butts and number of rows, and in depth and shape of kernels.

Determine uniformity of one character at a time by placing the like ears together. Cut $\frac{1}{8}$ to 1 point per ear according to the extent of non-uniformity. Subtract the sum of these deductions from 10 to get the final credit for the exhibit on uniformity.

II. Market condition—5 points.

The market condition of corn depends largely upon its maturity, freedom from mustiness and from injury due to insects or rodents, freshness of color, and firmness of corn on the cob. Old and deteriorated corn does not have a fresh color. If the ear twists easily when turned in the hand or if the kernels are loose on the cob, it indicates immature grain. The injury done by the rat and the rice weevil in the Islands is very great, and it spoils corn for feeding and growing purposes.

Estimate the condition by twisting and inspecting each ear separately. For each 4% of the total estimated seed in bad condition, cut 1 point. An exhibit with 20% of corn in bad condition would get zero.

III. Purity of Grain Color—5 points.

All the grains of an ear and all the ears of an exhibit should be uniform in color. Variation of color in the ears, or in the grains of the same ear, indicates mixed varieties.

For each kernel off color cut 1-12 point; a white dent having 6 red kernels would get zero. Subtract the total of the demerits from 5. The remainder represents the credits for the exhibit.

IV. Shape of ear—10 points.

Each variety of corn usually has its own characteristic shape and should be judged by the standard adopted. Undue emphasis has been placed upon the necessity of all varieties conforming to a cylindrical or slightly cylindrical shaped ear. While this shape is convenient for handling and while it may give the maximum number of grains, yet the lack of this character does not necessarily reduce the productivity of a variety. Ears should be straight, with straight rows of kernels and without undue swelling at the butt, or extreme tapering at the tip.

For each ear poor in shape, cut $\frac{1}{4}$ to 1 point, according to the degree of inferiority.

V. Proportion of ear—10 points.

By proportion of ear is meant the relation of length to circumference. It is determined by dividing the length of the ear by the circumference. Well proportioned ears vary from 1.2 to 1.5 times the circumference, taken $\frac{1}{3}$ the length of the ear from the butt. The standard length of typical selected ears is as follows:

Yellow Flint.....	18 to 21	cm.
Pasig Flint.....	14 to 16	cm.
Mexican June.....	15 to 18	cm.

Very short thick ears or long slender ones are ill-proportioned and undesirable.

For each ear out of proportion, cut $\frac{1}{4}$ to 1 point, according to the degree of inferiority.

VI. Butt of ear—5 points.

The rows of kernels should continue in regular order to the end of the cob and should be extended slightly over it. The butt should maintain the uniform size of the ear and should not be enlarged or contracted. A large shank, which usually accompanies a flat butt, is undesirable for it makes harvesting difficult.

Place the ears with desirable butts in a separate group. Cut each one with undesirable butt, $\frac{1}{8}$ to $\frac{1}{2}$ point according to degree of inferiority.

VII. Tip of ear—5 points.

The grains near the tip should be of the same regular shape, and of nearly the same size as the other grains of the ear, and should cover the tip. Short, double tips are undesirable.

For each ear with a long uncovered tip, or with a short or double tip, cut $\frac{1}{2}$ point.

VIII. Space between rows—10 points.

There should be some space between the rows of kernels. The extent varies with the varieties, being greater in those having flinty, round-shaped kernels. Compare ears of the same variety to get a correct basis for comparison of space between rows.

Too great a space between the rows either at the crown or near the cob indicates grains of poor shape and an ear of a low percentage of grain. It may also indicate immaturity.

Place in one group all the ears having well-spaced rows. Cut from $\frac{1}{4}$ to 1 point for each ear varying from these, according to the extent of variation.

IX. Per cent of grain to ear—15 points.

This is obtained by dividing the weight of the shelled corn by the weight of the entire ear and multiplying the quotient by 100. The best varieties should have not less than 80% of grain. The factors indicating large percentage of grain are depth of kernel, space between rows, and small-sized cobs.

For each per cent of grain less than 80%, or the standard adopted for the variety, cut 2 points. An exhibit falling $7\frac{1}{2}\%$ below the standard would get zero.

X. Trueness to type—10 points.

This has reference to the purity of the variety represented by the exhibit. The factors which determine type are length, shape and circumference of ear, depth, shape, color and quality of kernel, and number and pairing of rows. The ears should conform as nearly as possible in these characters to the variety standard.

For each ear varying from the type, cut 1-10 to 1 point, according to the extent of variation.

XI. Shape of grain—5 points.

The starchy or dent varieties of corn should have a deep wedge-shaped kernel. This permits of the greatest amount of grain on an ear. The flinty varieties usually have shallow kernels which are more or less rounded. The most desirable kernels should be flat but not too thin nor too pointed and should be uniform and well proportioned. Remove two kernels from the middle of each ear, for examination.

Cut $\frac{1}{4}$ to $\frac{1}{2}$ point for each ear varying from the type, according to the degree of variation.

XII. Uniformity of grain—5 points.

Uniformity in grain has reference to its similarity in shape, texture and color. Base the examination on the kernels removed. Texture uniformity can be determined by examining lengthwise sections of the kernels.

For each ear with grain varying from its type, cut $\frac{1}{8}$ to $\frac{1}{2}$ point, according to the extent of variation.

XIII. Weight of ears—5 points.

Weighing is one of the best means of determining the quality of the corn. Heavy weight indicates grain well matured, with good feeding qualities. Typical seed ears of each variety should approach a standard weight.

Weights and dimensions of the best ears of the following named varieties were taken at the College of Agriculture. The following table shows the averages.

<i>Name of Varieties.</i>	<i>Circumference.</i>	<i>Length.</i>	<i>Weight.</i>
Yellow Flint, Coll. Farm.	14.5 cm.	21.8 cm.	186.0 grams
Pasig Flint, Coll. Farm.	13.6 cm.	14.6 cm.	180.5 grams
Moro, Mindanao.	16.3 cm.	20.7 cm.	269.1 grams
Moro, Visayan.	15.4 cm.	17.3 cm.	208.0 grams
Mexican June, Coll. Farm.	14.9 cm.	15.3 cm.	179.0 grams

It is very evident that standards for each variety, likewise standards for different regions, are needed. The Moro corn, grown in Mindanao, is larger in every respect than that variety grown in other parts of the Islands.

Standards adopted at the College of Agriculture:

Yellow flint.....	175 to 185 grams
Pasig flint.....	125 to 135 "
Mexican June.....	170 to 180 "

For each ear weighing 5 grams below the standard adopted, cut $\frac{1}{8}$ point. An ear of yellow flint weighing 155 grams would get zero in weight.

CLASS OUTLINE FOR A GENERAL STUDY OF CORN (*Zea Mays*)

I. History

- a. Origin
- b. Scientific classification
- c. Improvement of varieties
- d. Increased yields and extended area due to:
 1. Products
 2. Great demand
 3. Improved cultural methods
 4. Evolution of machinery
 5. Ready response to culture

II. Commercial importance

- a. As a source of food
 1. For stock
 2. For man
 - b. As a source of wealth
 1. To the producer
 2. To the manufacturer—
- (a.) of products, b. of implements

III. Corn in the Philippines

- a. Introduction
- b. Varieties
- c. Provinces where grown extensively
- d. Importance
- e. Adaptability

IV. Seed selection

- a. Advantages and disadvantages
 1. Philippine varieties
 2. Imported varieties.

V. Improvement of varieties

- a. Better seed selection
- b. Hybridizing
- c. Ear-to-row method

VI. Soil and climatic requirements

VII. Yields

Different regions of the world.

VIII. Cultural methods.

Advantages and disadvantages of:

- a. Some preparation prior to, and at planting time
- b. Preparation only at planting time
- c. Planting at the proper depth
 1. On the surface
 2. In shallow furrows (listing)
- d. Frequent cultivation
- e. Native method (destroying the weeds, after they are about 20 cm. high, by plowing)

IX. Rotation

- a. Economical crops to use
- b. Advantages of rotation

X. Products

- a. Mature grain
 1. Feed for animals—Corn on the ear or crushed corn is used alone or with other grains
 2. Food for man—Corn meal is used as a basis for bread, mush, hoe cakes, etc.; entire corn is used for hominy

(The classes may read grocery catalogues, visit groceries, and ascertain from other sources, a complete list of the many foods made from corn.)

3. Alcohol, laundry starch, oil, etc.
- b. Grain in milky stage
 1. Vegetables, corn on cob, or removed
- c. Forage
 1. Soiling crop—The entire plant is cut when nearly mature, carried and fed to animals
 2. Ensilage—The entire plant is cut when nearly mature, is shredded and preserved in a silo (an air-tight structure.)
 3. Fodder—The entire plant, or any part of it, is cured when the grain is nearly hard, and fed dry
- d. Miscellaneous products

Fertilizer, mats, paper, fuel, corn cob pipes, etc.

XI. Storage

- a. Unhusked ear hung on a framework of bamboo
- b. Husked ear hung under shelter
- c. Shelled grain stored in large baskets in the home, in public *bodegas*—(Provincial or municipal *bodegas* might be constructed so as to guard against loss of grain due to moisture, rodents, or insects. Grain could be stored, credit be given, and corn redistributed, when it could be most economically used.)

XII. Increased production

- a. Adopt more intelligent methods of cultivation and crop rotation
- b. Employ better system of seed selection
- c. Conserve and apply the ordinary manures, so often wasted
- d. Economise, by using the plant

for compost, instead of burning it

- e. Extend the area by bringing new land under cultivation, keeping it cultivated, and maintaining its productivity by proper rotation and fertilization
- f. Better transportation

XIII. Noxious influences

- a. Insect pests—any, locusts, weevils, corn worm, stem borer
- b. Animal enemies—rodents, dogs, hogs, crows, etc.
- c. Fungi—smut, mildew, rust
- d. Harmful factors—weeds, winds, drought

XIV. Economical production

- a. Depends upon:
 1. Cost of production
 2. Yield
 3. Cost of marketing
 4. Market demand and value of products.
 5. Value of land

CLASSIFICATION OF SPECIES

Family.....	Graminae
Genus.....	Zea
Species.....	Mays

SUB-SPECIES

I. *Zea mays tunicata* (pod corn). Each kernel is inclosed in a pod or husk, and the ear is inclosed in a husk. This species is rare and is usually grown for its botanical interest.

II. *Zea mays everta* (pop corn). The endosperm of this species is very corneous, the kernel is small, pointed and oval in shape. The plants are small, each one usually bearing one or two small ears. This corn gets its name from its popping qualities. Popping is caused by heating the kernel and changing the moisture into steam, thus causing the hard, corneous endosperm to explode.

III. *Zea mays indurata* (flint corn). This corn has an endosperm largely corneous in texture, with a starchy streak extending from the endosperm to the crown. The kernels are hard, with rounded crowns, being sometimes slightly indented. The hard, corneous portion of the endosperm is a very desirable quality for corns grown in the Islands as it protects the corn, to a certain extent, from the attacks of the weevil.

IV. *Zea mays indentata* (dent corn). The kernels of this class are characterized by having small corneous parts at the sides of the endosperm; the remaining portion of the endosperm being starchy. The type of structure causes the crown of the kernel to draw in or shrink in drying, and thus we have corns with indentations of various forms. The kernel is long and wedge-shaped. The dent corn is grown most extensively in the United States. Owing to its starchy content, it is an easy prey for the weevil, and hence is not a desirable corn for the Islands.

V. *Zea mays amylacea* (soft corn). This corn has an endosperm which is entirely starchy in texture, and is without indentation. The kernel is large, shrinks uniformly, is shaped like the flint, but is soft. It is not grown very extensively, and not at all in the Islands.

VI. *Zea mays saccharata* (sweet corn). This corn has wedge-shaped kernels. When dry, they are wrinkled, and appear translucent and corneous. The wrinkling is due to the changing of starch to glucose (a form of sugar), which characterizes this corn and gives it its name. This corn is grown very extensively in the United States, being especially desirable as a vegetable. It is difficult to produce it in the Islands. The sweet flavor subjects it to attack by ants, and the larvae of different insects which burrow in the ear and stems.

HISTORY OF INDIAN CORN AND VARIETIES GROWN IN THE ISLANDS

Mays, maize, or Indian corn are American names adopted by the early writers for this cereal. According to De Candolle, Indian corn originated in the highlands, at a point intermediate between Mexico and Peru as it was early cultivated in both places. Harshberger states, "The evidence of archaeology, history, ethnology and philology points to southern Mexico as the primal habitat of this great New World cereal." While most authors disagree as to the exact origin of maize, yet they agree upon the general location and regard it as a plant of American origin. It was never found growing in the wild state. At the time of discovery, it was one of the staple foods grown in the upper La Plata valley, in Central America, Mexico and in several parts of the United States. The American Indians, who raised considerable corn at the time of the discovery of America, taught the early settlers how to raise and use it for food. They planted it in small areas around their temporary homes. De Candolle states that the burial-mounds of the natives of North America who preceded those of our day, the tombs of the Incas, and the catacombs of Peru, contain ears or grains of corn, just as the monuments of ancient Egypt contain grains of wheat. It was intimately connected with the religious rites of the ancient inhabitants of the countries bordering the Gulf of Mexico and the Caribbean Sea.

Corn is not well provided with means for either seed dissemination or self preservation. If it had not been grown by tribes of men, it would probably have become extinct.

Unlike rice, corn is not a native of the Islands, and there are but few varie-

ties grown in the Philippines. De Candolle also states that corn was cultivated in the Malay Archipelago under the name *jarung*, and that it was introduced into China either through Portugal or Spain before the end of the 16th century. Historical records do not state when it was first brought into the Islands or whether it was brought directly from Mexico or from China. Most authorities give the Spanish credit for bringing corn into the Islands from Mexico, at least 300 years ago. It has been grown more or less ever since.

Since the American occupation of the Philippines, a number of varieties of corn have been introduced. The only ones which have been successfully grown for any length of time belong to the subspecies *Indurata*, or flint corn. The best known local varieties are the native yellow flint and the Pasig flint. The first is one of the best varieties for general purposes.

The dent corns do not do well on account of their starchy content, but they have been successfully used in hybridizing with the native flint corn. Of the dent corns, the Mexican June has been distributed most extensively and has been tried for several years, but it cannot successfully withstand the conditions. At present most seed corn bearing that name is a hybrid with a flint corn. The Moro corn is said to be the product of hybridizing a native flint and an introduced variety of dent corn. It is hardy, produces large ears and is grown extensively in Cebu and in Mindanao.

TERMS FOR DESCRIBING CORN

Shape of ear

Cylindrical

Tapering

Very tapering

Length of ear

Long (more than 20 cm.)

Medium (16 cm. to 20 cm.)

Short (less than 16 cm.)

Circumference of ear

(Taken $\frac{1}{3}$ of the length of the ear from the butt)

Large (more than 15.5 cm.)

Medium (13 to 15.5 cm.)

Small (less than 13 cm.)

Number of rows of kernels

Many (20 or more)

Medium (14 to 18)

Few (12 or less)

Arrangement of rows

Single (space between rows uniform)

Paired (space wide between every other row)

Tip of ear

Covered (kernels extending to end)

Exposed (no kernels near end)

Butt of ear

a. (End view)

1. Flat (shank usually large, end of rows and place of attachment, same plane)

2. Moderately rounded (rows of kernels slightly project over end of cob)

b. (Side view)

1. Enlarged

2. Uniform

3. Contracted

Size of shank—(diameter of place of attachment)

Large (more than 22 mm.)

Medium (16 to 22 mm.)

Small (less than 16 mm.)

Size of cob (circumference taken $\frac{1}{3}$ of the length of the cob from the butt)

Large (more than 14 mm.)

Medium (10 to 14 mm.)

Small (less than 10 mm.)

Color of kernel

Yellow

White

Red
Variegated

Indentation of kernel at crown

Smooth—(characterizes flint corns)
Dimpled—(characterizes flint corns)
Dented—(characterizes starch or dent corns)

Shape of kernel

a. (Placed on germ side)
Wedge
Pointed wedge
Round
Obovate
b. (Edge view)
Parallel-sided
Pointed

Length of kernel

Long (more than 13 mm.)
Medium (9-13 mm.)
Short (less than 9 mm.)

Texture of endosperm

Largely corneous ($\frac{2}{3}$ or more flinty)
(Partly corneous (between $\frac{1}{3}$ and $\frac{2}{3}$ flinty)
Largely starchy (less than $\frac{1}{3}$ flinty)

Texture has reference to the proportion of starch and corneous part of the endosperm, excepting the scutellum. This is the part next to the germ which is rich in oil. The corneous portion appears hard or flinty and the other part starchy or white. The extent of each can be estimated by inspecting the grain, or more accurately calculated by examining cross and longitudinal sections of the kernels.

IMPROVEMENT OF THE VARIETIES OF CORN

A Method Advocated For General Use Selection Of A Variety.

Many foreign varieties of corn have been introduced into the Philippines with varying degrees of success. In most cases the result has been dis-

appointing. Because of a lack of knowledge of the laws governing acclimatization, enthusiastic attempts have resulted in failure.

Varieties of imported corn differ wonderfully in their behavior; some fail entirely to produce fruit; others produce enough to continue the culture; and a few produce good results the first generation, but poor results the second or the third generation. Exceptional successes are often followed by exceptional failures. The ordinary corn grower expects a good yield from the first harvest. He has neither the patience nor the time to continue the culture until it is acclimated and its behavior is well established. This work should be done by experiment stations or by persons especially interested, who realize that a period of years is necessarily involved. Foreign varieties, therefore, are not advocated for general use until they are acclimated.

Progressive farmers strive to improve their varieties of corn. They are advised to select seed from the best varieties found near home or from an adjoining province.

LINE OF IMPROVEMENT

Having selected a variety, the farmer should next decide upon a desirable type or standard to work towards, in the selection and the improvement of his seed corn.

The standard adopted should define the desirable ear as to shape, size, position on plant, shape, color and texture of kernel, and percent of grain. A few kernels approaching the type should be preserved for comparison with future products.

The rules for the selection of seed and the type established by the College of Agriculture, for the native yellow flint corn are as follows: Seed ears are selected in the field from the most

vigorous plants which have the tips of the ears inclosed in husks and the ears attached low on the plant. It is considered that corn plants with low-growing ears, will more readily withstand hard winds. The final selection of seed ears is made after the corn is husked and dried. The selected ears should possess, as nearly as possible, uniformity in length, circumference, and shape; and uniformity in texture and shape of kernels; and should approach the following standard:

Length of ear 18-21 cm.

Circumference of ear . . . 12.5-14 cm.

(Measurement taken $\frac{1}{3}$ the length of the ear from the butt.)

Number of rows in ear . . . 14-16

(Ill-proportioned ears are due to an unusually large or to a very small number of rows and they are undesirable).

Shape of ear—slightly tapering.

Shape of kernel—as nearly wedge-shaped as possible.

Length of kernel 10-12 mm.

Upper width 8- 9 mm.

Lower width 6- 7 mm.

Thickness of kernel 4-4 $\frac{1}{2}$ mm.

(The kernel should be uniformly thick, not thin and pointed at the end.)

Color of kernel—yellow with slight patch of white in crown.

Texture—largely corneous.

Kernels largely corneous have a hard, flinty appearance. A length-wise section of a kernel shows the endosperm largely corneous with a little starch extending from the germ to the crown and giving the crown a small whitish cap. The corneous material in a kernel more effectively resists insect attack.

The selection of seed corn at the College for the variety named is meeting with marked success. A comparison of 50 selected ears grown on the College farm was made with a like number of selected ears of the same variety from an exceptionally fine piece of corn grown by a near-by farmer. The results are shown in the following table:

Source.	Average Circumference.	Average length.	Average weight.
College...	14.5 cm.	21.8 cm.	186 grams.
Farmer...	13.6 "	20.3 "	173 "

This is evidence that improvement, if continued along definite lines, is certain.

EAR-TO-ROW METHOD.

The ear-to-row method of seed corn improvement involves a larger amount of work than does any other method. In the production of pedigreed stock, the work, to be successfully done, requires the attention of breeders who have had scientific training, who understand the laws governing breeding, and who know how to properly record results. That corn responds very rapidly to selection when properly bred in the ear-to-row method, is shown by the increased yields and improved vigor. Investigations at the University of Illinois have demonstrated that it is possible, after the first year to increase the yield more than 11 cavanes per hectare by using seed which is the product of cross-fertilization.

Increased yields cannot be maintained year after year, unless great care is exercised to prevent in-breeding. The breeder, in his desire to select only such ears as conform to his ideal, may find them all in one row—the product of a single ear. Continuing the culture with this product would not result successfully as this would involve in-breeding.

The Connecticut Experiment Station records yields which show a decrease

of from 35 to 45% the first generation, and 20 to 25% the second generation, as a result of in-breeding.

The original selection of seed ears and the adoption of a desirable standard to govern future work in seed selection and improvement, are similar to those advocated for general use. A beginning can well be made from the good ears of the best variety of your province, or from acclimated seed.

The purpose of the breeding is to work towards a high yield in conjunction with such qualities as the breeder may desire, as an increased oil content, a greater proportion of corneous part or of starch in the endosperm, an improved shape of ear and kernel, or a better position of ear on the stalk.

A practical number of ears to use in the breeding plot is 96. When it is difficult to find that number of desirable ears, a smaller number is often used.

The seed ears, having been selected, should next be numbered, consecutively. When planting time comes, plant the seed of each ear in a separate row, numbering that row to correspond to the number of the ear from which the seed was obtained. It is advisable to keep some seed on the ear to be used later, in comparing it with the product, to note any possible improvement. This also provides against the complete destruction of the culture, resulting from insects or drought.

The plot must be isolated from other varieties in order to prevent undesirable pollination. Before the time of inflorescence, the only attention the plot needs, besides good cultivation, and the destruction of parasites, is the removal of plants lacking vigor or infested with fungus, or plants of abnormal development.

DETASSELING.

Especial attention is required about the time of inflorescence, for the flowers

appear rather suddenly. The tassels must be removed from the plants of part of the rows to provide against self-pollination. The method adopted is to pull the tassels from every other row—the even numbered rows—and from any undesirable plants in the odd numbered rows. The operation must be repeated each day until all flowers have appeared. The real gain depends upon the extent to which this operation is properly done. The seed must be taken from the detasseled rows. All the other corn must be discarded as seed, as it may be no better than seed produced in the ordinary way.

Field Selection of Seed.

Before harvesting, mark the ears of the even numbered rows which, due to place of attachment, vigor of plant, size of ear or covering of ear, are most desirable. The final selection should be made from these, unless they are found in rows poor in yield and quality.

The product of each row should be separately harvested. When the corn is dry, the total weight and the number of good ears should be determined.

The ears for the succeeding breeding plot must come from the detasseled rows, and must represent the highest total yields from entire rows. Ears should be selected for seed only from such high yielding rows; ears, otherwise distinctly exceptional, being discarded when they come from rows of lower yield. The remaining ears of ordinary size and quality from the exceptional, detasseled rows are to be used for the general plantings, but all the corn grown in the rows not detasseled, must be discarded as seed.

The selected ears for the succeeding breeding plot should conform as closely as possible, to the standard adopted and they should come from the best

representative rows. The extent to which one should describe the seed ears and compare and record results, depends upon the purpose of the grower. The farmer wants the best seed with the least possible work. He may not be willing or in a position to spend the time necessary in carefully describing the selected seed and in recording results in minute detail as is necessary in the production of pedigreed stock. A good grower may often lack the skill it requires in manipulating the breeding plots, in order to prevent in-breeding when the selection of seed is confined entirely to the product of the original seed. He does realize however, that increased yields and variety improvement are possible when seed is carefully selected from ears produced through cross-breeding, but he eliminates all the detail work which requires so much time. His procedure is based upon scientific practice generally advocated by the experimental stations, but he does not necessarily confine his seed selection to the product of the original seed. To avoid the effects of in-breeding on his pedigreed strains, he introduces, each year, ears of the same variety, selected from another source, and uses them as sires. These introduced ears may be planted in the rows having odd numbers. The ears from the even numbered rows should be selected according to directions given, and should again be used in planting the even numbered rows of the next breeding plot.

This procedure also avoids the necessity of, duplicate breeding plots, multiplying seed fields and special planting plans for avoiding in-breeding when selection is confined to the original seed.

A comparison of the crop from seed produced in the breeding plot should be made with the neighbor's crop pro-

duced from ordinary seed under similar conditions. Any gain or loss in yield and quality should be noted.

The farmer who breeds corn should observe the following essentials: 1. The maintenance of a breeding plot for the production of all his seed. 2. The selection of seed-ears used as dams, from detasseled rows, from plants representing high yield, good quality, and ears approaching a desirable standard. 3. The introduction of standard seed ears of the same variety, used as sires. 4. The isolation of the breeding plot. 5. A close observation of gain or loss in yield and quality.

According to the professional breeder's practice of the ear-to-row method, the selection of seed ears is confined entirely to the product of the original seed grown in one or more breeding plots. The ears may be selected with a view of developing any given quality, but the breeder accomplishes results more accurately and more speedily than does the ordinary grower.

Selection of seeds for high oil content by the Illinois Station resulted after six generations, in a gain of nearly 2%.

Each generation, ears are carefully selected from the representative rows. They are weighed, measured, and accurately described. Complete records are kept in detail. Multiplying plots and special plans for planting are devised in order to avoid the effects of in-breeding. The system requires a careful attention to detail which does not appeal to the busy grower.

For a more detailed description of the ear-to-row method and the plans for recording results, the reader is referred to the Illinois Experimental Station Bulletin No. 100.

Both the farmer's and the professional breeder's method of procedure will

bring good results. The farmer who breeds corn may not be able to give a complete pedigree of his corn as the professional breeder does, but he reaps nearly all the benefits with much less effort. The corn grower must depend to some extent upon the advice and the results obtained by the experimental stations for methods of planting and seed selection.

Progressive farmers are usually quick in adopting the best methods of seed improvement. They are undoubtedly the best demonstrators of new methods, as well as the best agents in the distribution of knowledge of scientific agriculture.

EXERCISES

I.—A. Study of the Corn plant under Field Conditions.

The class should grow the corn used for this exercise. Plots of 100 square meters can be prepared, planted and cultivated in different ways. The best methods can be compared with the customary ones. The results of home fertilizers such as ashes, manures of different animals, and bat guano, found in the Islands, can be obtained.

From any one of the plots receiving good treatment, obtain the following information:

1. Average number of plants per hill
2. Total number of sterile plants
3. Average height of plants
4. Proportional height of attachment of ear on plant
 - a. High
 - b. Medium
 - c. Low

The proportion of height of ear attachment, to height of corn, is obtained by dividing the height of the place of attachment, by the total height of the plant.

5. Yield
 - a. Total number of ears harvested

- b. Number of good ears
- c. Number of poor ears
- d. Average weight of each kind
6. Depth of root and extent of feeding.

7. Comparison of results of plots which received good preparation and cultivation, with the results obtained from corn grown and cultivated in the usual way.

8. The weight in kilos of the corn blade fodder made from 100 square meters.

B. Problems.

Given the following facts:

Weight of one cavan of dry corn in ear..... 67.5 kg.

Weight of one cavan of dry corn shelled..... 54.0 kg.

One cavan = ... 2.128 bushels

Total production of shelled corn in the P. I. 1913-14..... 339,000 cavans

Total hectarage of corn in P. I. 1913..... 383,709.

Total production of corn in the U. S. 1909..... 2,120,566.008 cavans

Total hectarage of corn in the U. S. 1909, ... 79,748,317.

Solvé:

1. A merchant buys 1000 cavans of corn in the ear. If the corn is 84% grain, how many cavans of shelled corn does he get? How many cavans when only 77% grain? What is the % of grain when the general market recognizes 67.5 kilos of corn in the ear and 54 kilos of shelled corn as one cavan?

2. Find the average yield of corn per hectare for the United States; the Philippines.

3. If each farmer in the P. I. should increase the average yield of his corn crop 10%, what would be the increase in the total production?

4. Calculate the number of ears in a cavan when the ears weigh 100, 140, 160, 180, and 200 grams respectively.

5. Take an average sized ear of corn.

a. Get the following information:

Number of rows of kernels

Number of kernels per row.

Number of well-shaped kernels, desirable for seed.

Number of small and poorly shaped kernels at tip and at butt.

Total number of kernels.

Per cent of kernels desirable for seed.

b. If a farmer plants his corn in rows, 1 meter apart, with hills 80 centimeters apart and 3 kernels per hill, calculate the amount of ground he can plant with one ear; calculate the number of ears needed to plant one hectare, and the value of the seed ears at 1 centavo per ear.

6. A farmer has 100 cavans of corn. Which is more profitable—to sell it at 1 centavo per ear (estimating the ears as averaging 160 grams) or to sell it at \$1.00 per bushel?

7. Calculate the missing terms in the following, and place the result in the blanks.

Weight in Grams.		Cob.	% of Grain.
Entire ear.	Grain.		
175	143.5		
185			82
	151.2	28.8	
140.2		41.8	
		18.14	74
211.4			79
	138.4		82
184.6		40.6	

8. If a hectare of corn requires the labor of 1 man for 24 days, and the use of a carabao (valued at 80 centavos per day) for 12 days, how many cavans of corn, valued at ₱3.50 per cavan must he raise, in order to realize 1 peso a day for his labor after giving $\frac{1}{3}$ of the crop as rent for the land?

9. Corn differs very little from rice in nutritive value. (U. S. Bulletin No. 565). If rice, due to some disaster, sells for ₱8.00 per cavan how much would a family, which usually consumes 2 gantas of rice daily, save in a month by substituting each day one ganta of corn worth ₱3.50 per cavan?

EXERCISE II.

Calculation of yields. Let Class fill in the blanks.

Planting distance in meters	Plants per hill	Plants per hectare would be:	If each plant bears	Yields in Kg. per hectare would be:	Value at ₱400 per cavan would be:
1 by 1	1	.....	One 40 gm. ear	.....	.....
1 by 1	1	.....	" 70 gm. ear	.....	.....
1 by 1	1	.....	" 100 gm. ear	.....	.....
1 by 1	1	.....	" 130 gm. ear	.....	.....
1 by 1	1	.....	" 160 gm. ear	.....	.....
1 by 1	1	.....	" 190 gm. ear	.....	.....
1 by 1	1	.....	" 220 gm. ear	.....	.....
1 by 1	1	.....	" 250 gm. ear	.....	.....
1 by 1	2	.....	* " 90 gm. ear	.....	.....
1 by 1	2	.....	* " 120 gm. ear	.....	.....
1 by 1	2	.....	" 120 gm. ear	.....	.....
1 by 1	2	.....	" 150 gm. ear	.....	.....
1 by 1	2	.....	" 180 gm. ear	.....	.....
1 by 1	2	.....	* " 150 gm. ear	.....	.....
1 by 1	2	.....	" 160 gm. ear	.....	.....
1 by 1	3	.....	* " 120 gm. ear	.....	.....
1 by 1	3	.....	" 150 gm. ear	.....	.....
1 by 1	3	.....	" 180 gm. ear	.....	.....
1 by $\frac{1}{2}$	1	.....	" 100 gm. ear	.....	.....
1 by $\frac{1}{2}$	1	.....	" 130 gm. ear	.....	.....
1 by $\frac{1}{2}$	2	.....	* " 110 gm. ear	.....	.....
1 by $\frac{1}{2}$	2	.....	" 140 gm. ear	.....	.....
1 by $\frac{1}{2}$	2	.....	" 130 gm. ear	.....	.....

*The two or three numbers represent the weights of ears when the hill has more than one plant.

Is it essential to try to grow larger ears or to increase the number of the average sized ears? What is a good stand of corn plants per hectare? An ear of corn should be of what size to sell best on the market? Does your yield consist mostly of small ears with a few large ones, or mostly of the marketable size with a small number of inferior ears?

Make drawings showing texture and shape of kernels for the different varieties.

- | | A | B | C | D |
|-----|--------------------------------------|---|---|---|
| I | (Longitudinal section) | | | |
| II | (Cross-section near crown) | | | |
| III | (Cross-section near tip or germ end) | | | |
| IV | | | | |

(Entire kernel, embryo side)

V

(Entire kernel, opposite embryo side)

Let the drawings in the horizontal rows represent different varieties of corn as Moro, Pasig Flint, Native Yellow Flint and Mexican June. Let the drawings in the vertical rows represent the different views of corn of a variety. Represent the different parts of the kernel as follows:

Corneous portion (part rich in protein)—heavy dots.

Starchy part—outlined.

Scutellum (part next to embryo rich in oil)—lightly shaded.

Embryo or germ—outlined and shaded. The drawings should be four times the natural size.

G o g o

(Continued from page 226)

towns or may be at the coast, and there is said to be no uniform difference in price between the hill country and the coast.

The principal use of gogo is for washing the hair. It produces a luster which is highly prized. It is also believed by some to have some value as an insecticide, but others claim that it has no such use whatever. It is rumored that the seed are used for medicine, but real information as to this is not available. In Cavite, where the plants are common, the seed has no local value, but in Nueva Ecija, they are sold in tiendas at two for a centavo, being used for children's playthings as well as, according to report, for medicine.

In some parts of the islands, the stem is used instead of the seed for propagation. Pieces from half a meter to a meter long and three to five cen-

timeters in diameter are planted with the base in the ground, and are reported to yield a reasonably high percent of sets. If completely buried, they do not live.

Of the material brought in, the Cavite seed is larger than that from the northern provinces, and the pods are very much larger. The Pangasinan seed is the smallest of all, and only six are produced in a pod. The Nueva Ecija pods contain at the most twelve seeds, and the end is broken showing that at least one more was originally present.

Both the Department of Forestry and the Department of Agronomy have planted seeds, and the plants are expected to be given treatment varying from mere planting in the edge of woods, to real cultivation.

E. B. C.

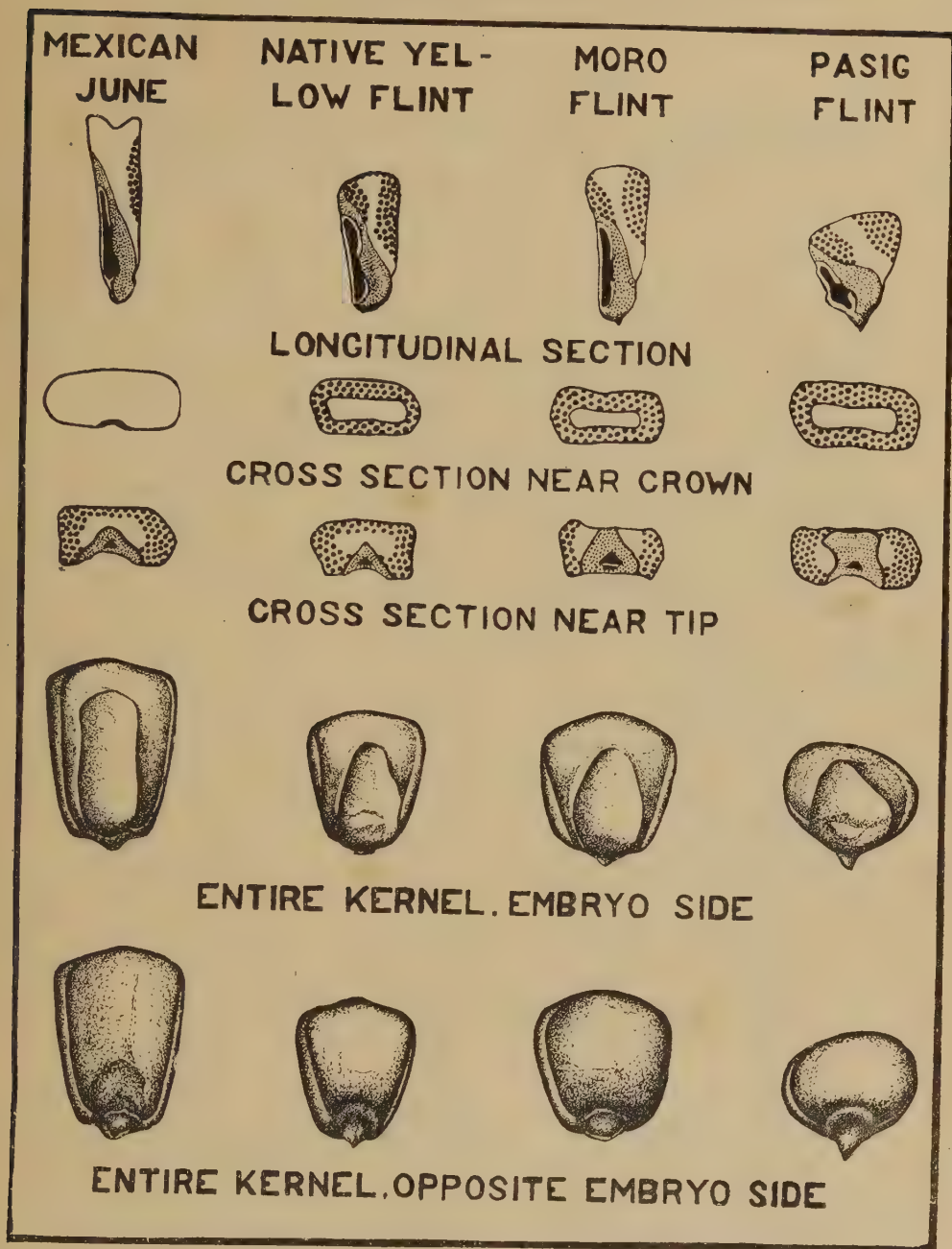


PLATE 1.

Drawings showing texture and shape of typical kernels representing four varieties of corn.

Corneous part—heavy dots.

Starchy part—outlined.

Scutellum—shaded lightly.

Embryo—shaded heavily.

UNIVERSITY OF THE PHILIPPINES

COLLEGE OF AGRICULTURE

LOS BAÑOS

The College of Agriculture is now in its sixth year, and has a student body of nearly 400. It occupies a tract of about one hundred and twenty-seven hectares on which every important crop in the Philippines is under cultivation. It has a large series of varieties of leading crops and very numerous introduced plants under test and observation. The number of distinct cultures not including series of fertilizer experiments is more than two thousand. The college has five concrete buildings and one of mixed materials.

The courses are:

A six-year course based on the Intermediate course of the public schools, and leading to the degree of Bachelor of Agriculture.

A four-year course based on completion of the public high school course, and leading to the degree of Bachelor of Science in Agriculture.

A two-year course, most students in which are high school graduates, for the training of forest rangers.

A four-year course, based on completion of the public high school course, leading to the degree of Bachelor of Science in Forestry.

The Maquiling Forest Reserve is adjacent to the college farm and furnishes the opportunity for field practice in forestry.

Graduate work leading to the degree of Master of Science is given to persons holding the degree of Bachelor of Science.

Tuition for non-residents of the Philippines is ₱150.00 a year.

The next college year will open June twelfth, 1915.

For further information address the Dean of the college.

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